IREC

Shaping Energy for a Sustainable Future

PRODUCTS
SOLUTIONS
SERVICES

TECHNOLOGY CATALOGUE

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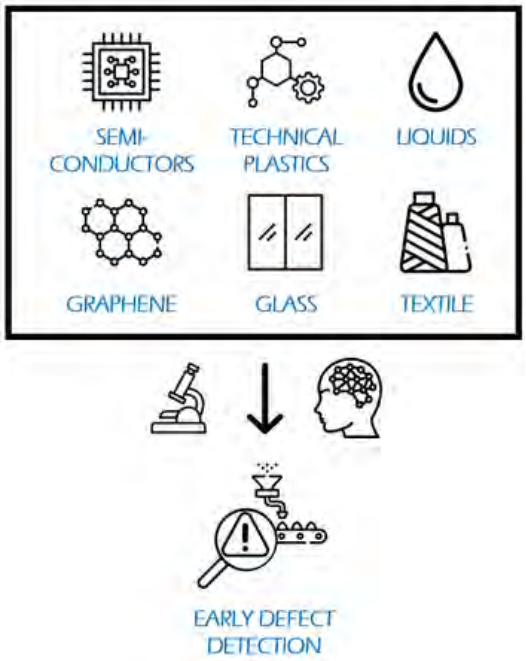
CUSTOMIZED INDUSTRIAL PROCESS MONITORING

USING IN-LINE OPTICAL AND OPTOELECTRONIC INSPECTION

THE CONCEPT



ADDED VALUE

- Non-destructive
- Highly customizable

TRL

7

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PRODUCT DESCRIPTION

- Modular and adaptable **multi-sensor head** for the **in-line monitoring of industrial processes**
- Uses **advanced AI** and **combinatorial analysis** to deliver clear and direct outcomes
- Can cover the **analysis of many different materials**, from complex semiconductors to glass or plastic
- **Non-destructive** characterization to assess the quality of the final or intermediate products
- Helps to **identify defects and small deviations** of the physico-chemical properties of the materials, allowing early correction and/or prevention of pre-critical production faults
- **Contributes to the digitalization** towards industry 4.0

APPLICATIONS

- Manufacturing industrial processes requiring in-line monitoring for high-value products
- Customized inspection systems for materials' assessment
- Advanced characterization of complex materials

DESIRED PARTNERS

- Fabrication/manufacturing industries
- Metrology companies
- Quality control end-users

EXPECTED BENEFITS

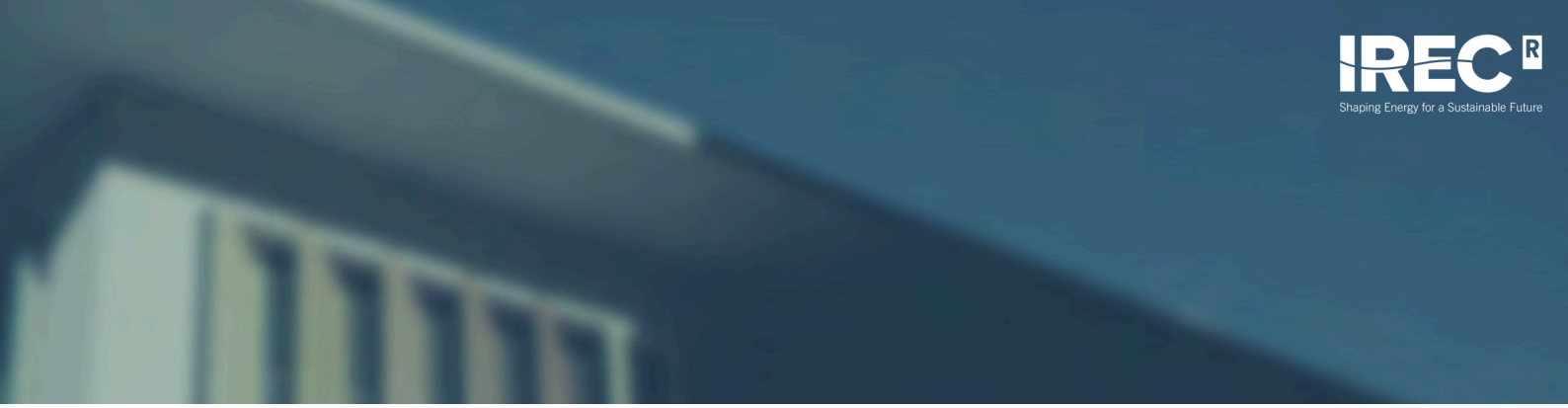
Real-time monitoring

Production optimisation

Saves material

Reduces costs

technical details



TYPE OF ANALYSED MATERIALS

The present solution allows to perform an extensive and non-destructive local characterization of many different materials, in a fast and practical way, with none or minimal sample preparation. The materials under analysis can be: composites, chemical products, liquids, ceramics, graphene, organic materials or even agrifood.

DETAILS OF THE ANALYSIS

Can analyse a variety of **properties**: Quantification of composition (including dopants and additives), chemical structure, crystallinity, intrinsic materials' strain, poli-types, and optical and electrical properties.
Can use a variety of **techniques**: *structural and physicochemical* (IR, Raman, XRF, fluorescence). *optical* (reflectance, transmittance, thermography, UV/VIS/IR inspection) or *optoelectronic/electrical* (I-V, dark I-V, spectral response/quantum efficiency, electroluminescence, resistivity, capacitance, photoluminescence spectroscopy).
Employs automatic Big Data **analysis** using analytical and statistical AI methods.

IMPLEMENTATION

Several pilot plants have been implemented for different industrial processes, together with: ZSW, Sunplugged, Saule, LENZ, Dismeco, Graphenea, Lurederra, Ecopol, checking materials as diverse as silicon in photovoltaic panels, polymers, graphene or classification of glasses for recycling.

Sorting system - Pilot line for recycling plastic in Lurederra (Navarra)

Process monitoring system- pilot line for CIGs PV production in ZSW (Sttugart)

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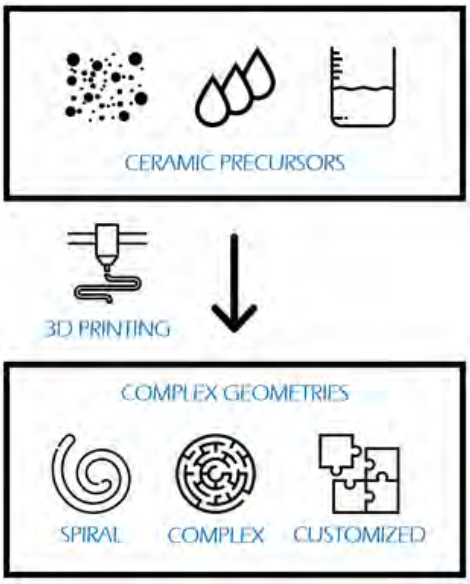
TECHNICAL CERAMICS WITH TAILORED GEOMETRIES

MAKING MONOLITHIC SOLID OXIDE SHAPES BY 3D PRINTING

THE CONCEPT



ADDED VALUE

- Increased robustness
- Increased thermal shock resistance
- Reutilization of waste heat for reforming processes

TRL

4

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PRODUCT DESCRIPTION

- Original 3D printing process able to fabricate **customized ceramic structures** in a single step
- Allows the fabrication of **monolithic** ceramic **complex geometries**, not possible using other processes
- **Reduces cost** of implementation
- **Minimizes** the waste of **materials**
- Allows **integration of functionalities** by customizing final product features, such as enhanced active surface area

APPLICATIONS

Focuses on manufacturing of devices made of **ceramic functional materials** for several applications, such as:

- Solid oxide cells fabrication
- High temperature packaging
- Customized testing setups
- Catalytic reactors

DESIRED PARTNERS

- System integrators
- Investors
- Final users

EXPECTED BENEFITS

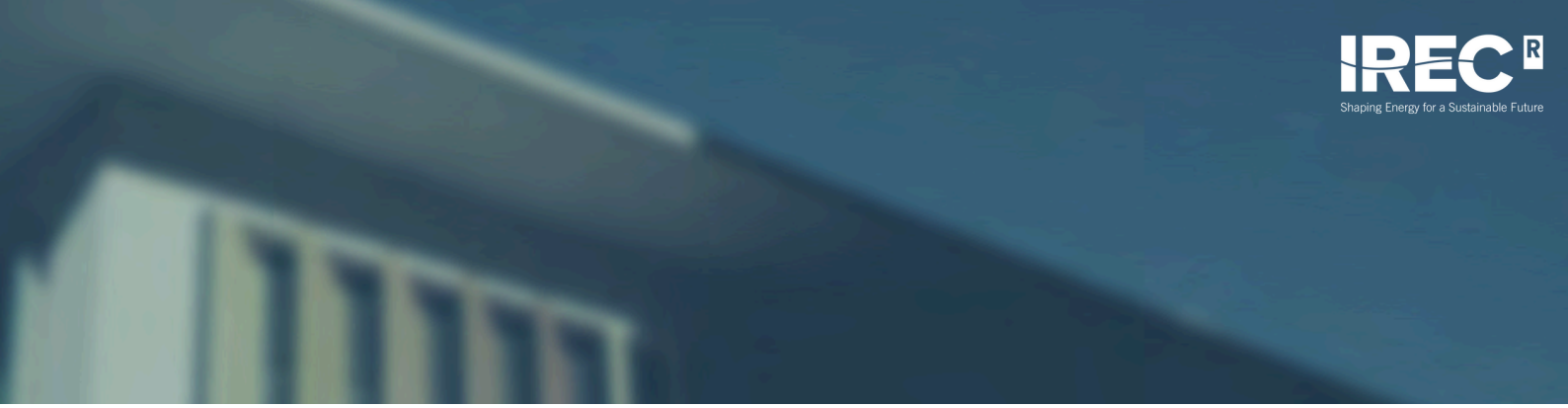
Feasible complex structures

Minimised gas leakages

Reduces waste

Reduces cost

technical details



INNOVATIVE SOLUTION

This manufacturing solution solves the limitation of the ceramic industrial fabrication technology, limited to tape cast sheets and extruded shapes, which limits the geometries of the SOC devices, and thus their performance. It eliminates the use of seals and interconnect plates (the main points of failure), allows control of porosity gradients and a variety of materials in the same product. The ceramic fuel cell will integrate all the elements of a SOFC in one monolithic structure that requires complex geometries only obtainable via 3D printing. Such geometries do not currently exist in the ceramic 3D printing field. This method overcomes a series of technical problems related to 3D printing machines and ceramic slurries.

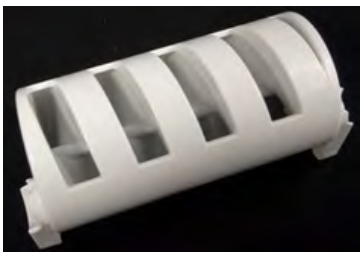
COMPETITIVE ADVANTAGE

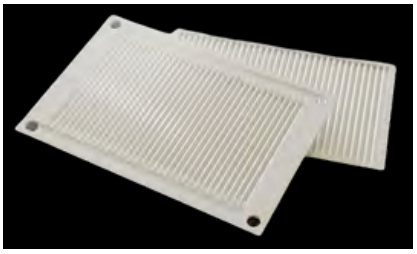
Complex geometries- can solve traditional problems such as the presence of weak joins and leakages for Solid Oxide Cells, maximize the active area in photocatalysts or improve mass and heat transfer in functional devices (SOC, catalytic reactors)

Hierarchical complexity- allows designing features with shape complexity across multiple size scales to maximize active surface in SOCs or catalytic reactors as well as improve mechanical properties (bioinspired materials) in all the devices under development

Material complexity- allows material differently processed at different points resulting in a variety of properties, including a combination of materials. This allows generating highly interesting porosity graded structures for SOCs or active composites for SOCs

Functional complexity- allows direct fabrication of devices integrating different functionalities





Examples of possible complex geometries for SOC devices or catalytic reactors.

Patent number EP3754768A1

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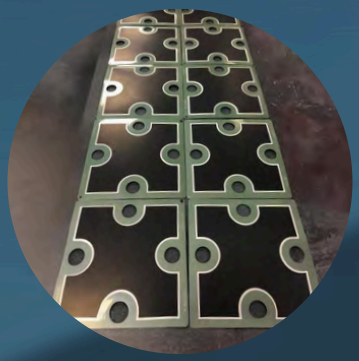

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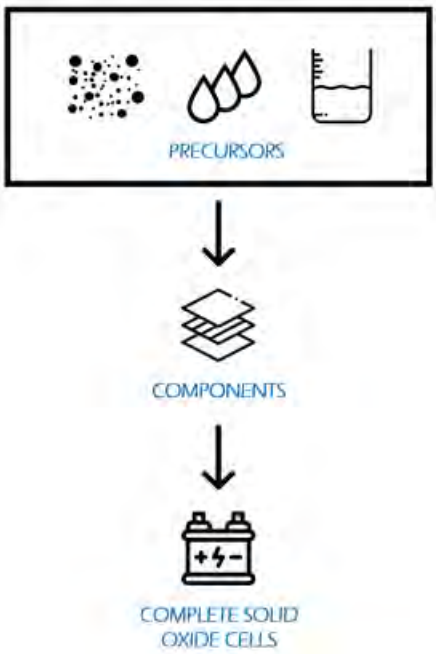
INNOVATIVE MANUFACTURING OF SOLID OXIDE CELLS

DEVICES FOR USE AS SOLID OXIDE FUEL CELLS OR ELECTROLYSERS

THE CONCEPT



ADDED VALUE

- High performance
- High stability of the cells

TRL

4

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PRODUCT DESCRIPTION

- Fabrication of **solid oxide cells** by **multiple methodologies**
- Implementation of **functional interlayers** for improved stability and performance
- **Thin-film fabrication** methods to reduce amount of critical raw materials
- **Simplified manufacturing** by single-step multimaterial 3D printing
- **Decreased OPEX costs** by innovative fast thermal processing techniques

APPLICATIONS

Focuses on manufacturing of **electrochemical devices** made of **functional ceramic materials** for several applications:

- Solid oxide fuel cells
- Solid oxide electrolysers

DESIRED PARTNERS

- System integrators
- Investors
- Final users

EXPECTED BENEFITS

Simplified fabrication

Mechanical robustness

Reduces waste

Reduces cost

technical details

AVAILABLE MANUFACTURING TECHNIQUES

IREC is capable to build highly-performing SOCs using a combination of fabrication and processing techniques, ranging from industrial 3D printing to:

- **Screen-printing/Spray coating**: Standard micron-range deposition techniques
- **Pulsed laser deposition/Sputtering**: Standard nano-range deposition techniques
- **Multimaterial 3D printing**: In-house development of 3D printing of ceramics
- **Rapid thermal processing**: Surface specific high temperature sintering, within the second-scale
- **Ultrafast high-temperature sintering:** In-house development of high temperature sintering within the minute-scale

ADDITIONAL DETAILS

IREC technologies on SOC fabrication can:

- Fabricate and functionalize large area cells (~90 cm^2)
- Be compatible with industry-level SOC technology
- Deliver cells with improved performance and stability against degradation

IMPLEMENTATION

Complete electrolyser systems have been constructed and validated in **EDAR Sabadell** (1 kW), **Barcelona** (1 KW) and **CELSA** (5kW)

IREC
SOC stack

0.5 kW electrolyser
(Sabadell)

1 kW electrolyser
(Barcelona)

5 kW electrolyser
(CELSA)

Patents: -WO2023021217A1 + EP22382691A

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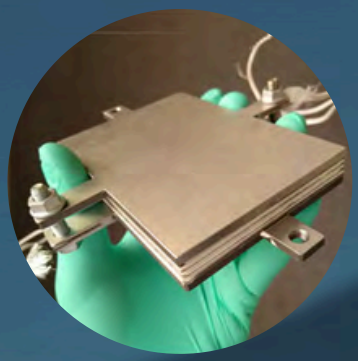

HIGH POWER DENSITY SOC STACKS

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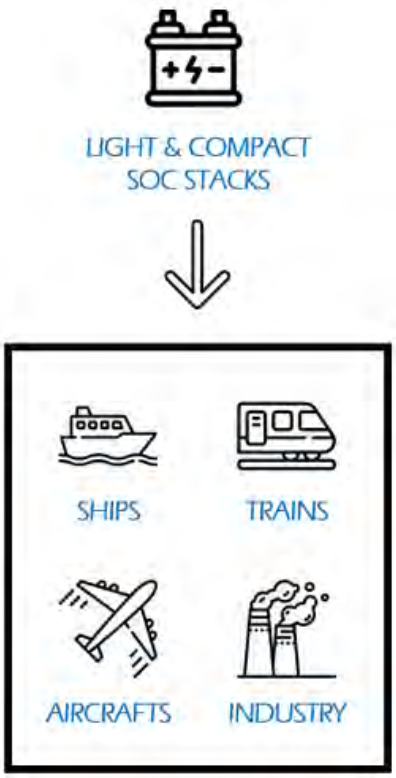
BREAKTHROUGH TECHNOLOGY FOR HEAVY MOBILITY AND CARBON-INTENSIVE INDUSTRY

THE CONCEPT



ADDED VALUE

- Modular production
- Easy to recycle
- Replaceable spare parts

TRL

5

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PRODUCT DESCRIPTION

- **Highly performing** electrolyte-supported solid oxide fuel cells using a 3D printing technology
- The **improved design** boosts the capacity compared to conventional cells, offering optimal performance versus stability compromise
- **4x higher power density** compared to conventional SOCs
- Easily combined into **stacks**
- **Reduced** amount of **interconnect** material
- Can be **fuel flexible** (ammonia, methanol, methane or biogas) by using a reformer

APPLICATIONS

These 3D-printed SOFCs are specially designed for

- Heavy-weight transport, such as aircrafts, trains, marine segments
- Carbon-intensive industries aiming at decarbonising

DESIRED PARTNERS

Stack manufacturers, power system integrators in heavy transport and carbon-intensive industries.

EXPECTED BENEFITS

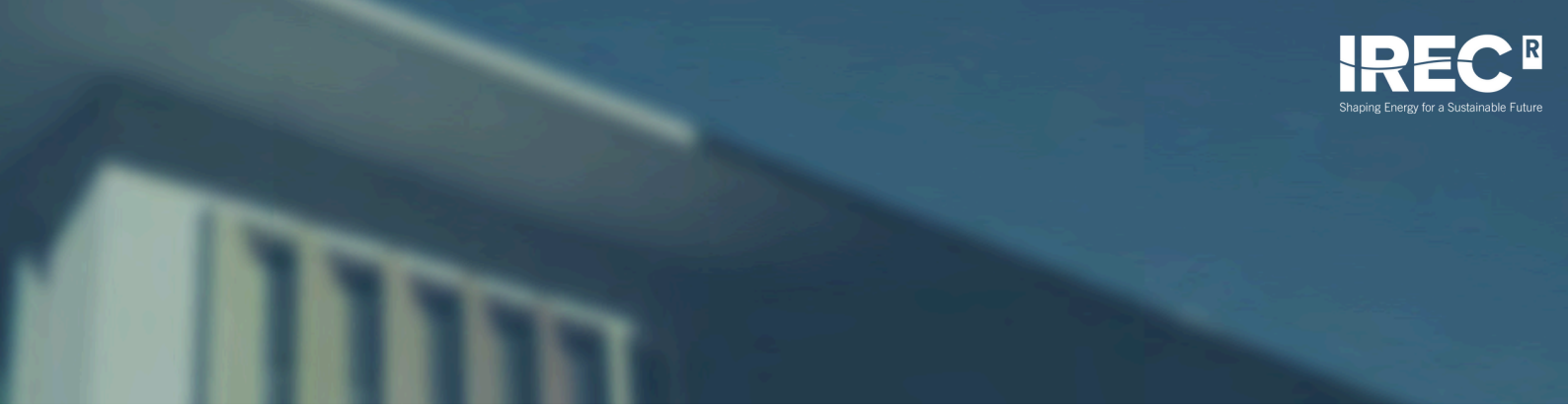
Highest output/weight

Improved efficiency

Lightweight

Quick refuelling

technical details



INNOVATION SOLUTION

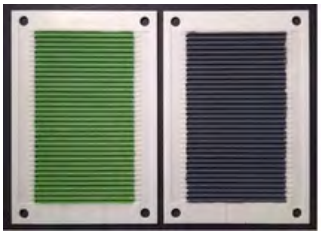
Our design increases the area of the electrolyte, correlating with an increase of performance, achieving higher volumetric and gravimetric densities when compared to standard SOFC.
The design confers mechanical support to the cells, making them more durable and resistant to deformation. Our 3D printed SOFCs can easily be combined in stacks, which can be further integrated into complex systems and subsequently integrated into final applications, such as aircrafts, trains or marine applications, or industries.
3D printing is a versatile technique allowing to produce different shapes that might fit into a plethora of designs.

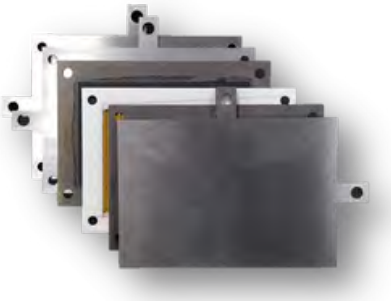
COMPETITIVE ADVANTAGE

- ***vs* batteries**: Lower operational costs, better autonomy, shorter refuelling times, improved efficiency, no harmful emissions, scalability, lower weight
- ***vs* PEM**: Higher energy efficiency (attributed to their high operating temperatures), ability to use a variety of fuels, no need for precious metal catalysts
- ***vs* standard SOFC**: Higher power density, modular production process (stack shape customization, easier scalability, lower investment), more resistant
- Current proof-of-concept is > 600 W/kg, 2 kW/L (output power/stack weight & volume), aiming at implementing additional improvements

IMPLEMENTATION

We are currently collaborating with H2B2/IPCEI initiative to develop this technology.
Patent number: EP19382509.





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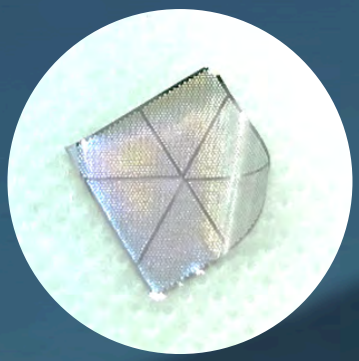
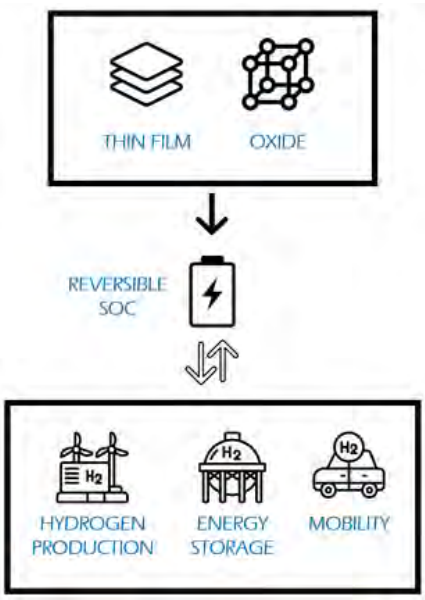


ULTRA-COMPACT REVERSIBLE SOLID OXIDE CELLS

POCKET-SIZED KW-RANGE STACKS

THE CONCEPT



ADDED VALUE

- High density current per volume
- High production yield at low cost

TRL

3

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PRODUCT DESCRIPTION

- Revolutionary **ultra-compact** thin film **reversible** solid oxide **electrolyser-fuel cell**
- **Pocket-sized** kW-range stacks
- **Negligible content** of critical raw materials (CRM)
- Able to **efficiently store renewable** energy and **generate** it through the use of **green hydrogen**
- Suitable when **small-sized constraints** or long-term applications are required
- Lower working temperature range than current technology

APPLICATIONS

- **Hydrogen production** (chemical + metallurgical industry)
- **Energy storage** (Grid-storage, off-shore generation, decentralised off-grid scenarios, solar energy)
- **Mobility** (Land, naval, air)

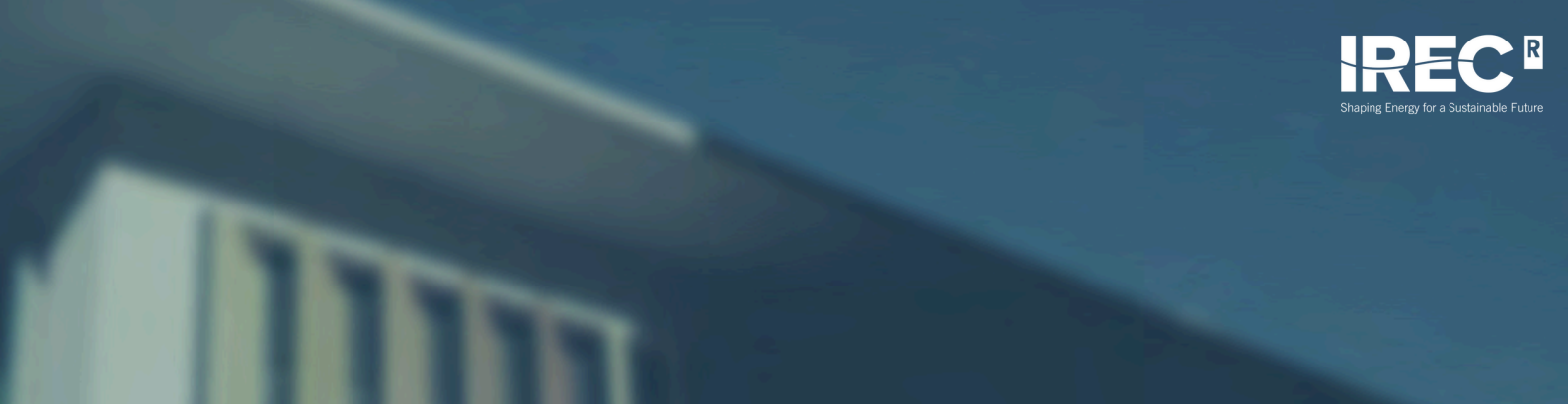
DESIRED PARTNERS

- Microelectronics foundry
- System integrators

EXPECTED BENEFITS

Ultra-compact | Low CRMs content | Reversible | Low cost

technical details

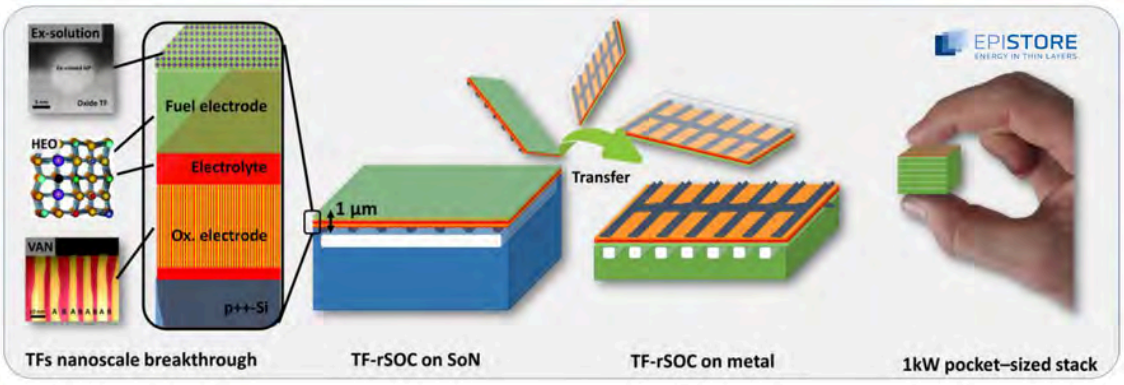


INNOVATION SOLUTION

This technology is a thin film reversible Solid Oxide Electrolysis Cell (SOEC) which is able to operate at high current densities and at lower temperature range (T<650°C). In addition, it requires negligible quantities of Critical Raw Materials. The use of thin film technology (< 1µm) represents a technological innovation driven by nanoscale phenomena. Furthermore, the solution combines nanoscale advances and materials yet to be explored with pioneering to provide new ultra-compact and fast-response power–to–gas (P2G) and power–to–power (P2P) storage solutions with high performance.

KEY ELEMENTS

- Thin Film Reversible Solid Oxide Cells: < 1µm thick cells
- Pocket-size stacks
- Ultralow content of CRMs: 0.048 g/kW in our ultracompact cell vs. 19-58 g/KW conventional SOFC
- Better P2G efficiency (95%) compared to other electrolysers, also P2P efficiency is increased (65%).
- High production yield at low cost: Use conventional microelectronics manufacturing technology
- Cheaper hydrogen production enables a larger uses cases for green hydrogen. The competitive production of green hydrogen using IREC's SOEC contributes to increase the integrate higher shares of renewable energy sources.



Patent number: WO2024017941+ EP23383322

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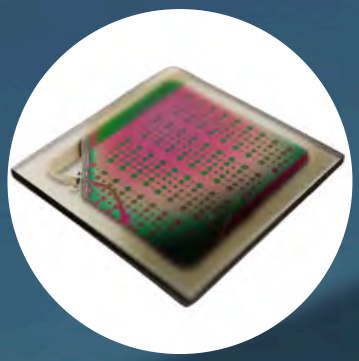

HIGH-TEMPERATURE OXYGEN ION BATTERY

ENERGY STORAGE DEVICE FOR HARSH ENVIRONMENTS

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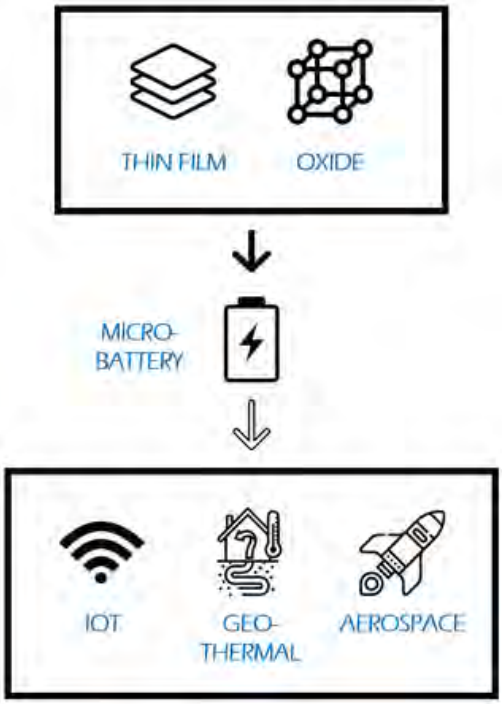
THE CONCEPT



ADDED VALUE

- Battery operation at high temperatures
- Tailored design

TRL

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PRODUCT DESCRIPTION

- Solution for **energy storage** having high energy and power density
- **Rechargeable** battery based on oxygen ions
- Made of **oxide ceramic materials**
- Uses more **abundant chemical elements**, the device is lithium-free
- Working temperature is 150-400 °C

APPLICATIONS

- Industrial IoT
- Geothermal
- Aerospace

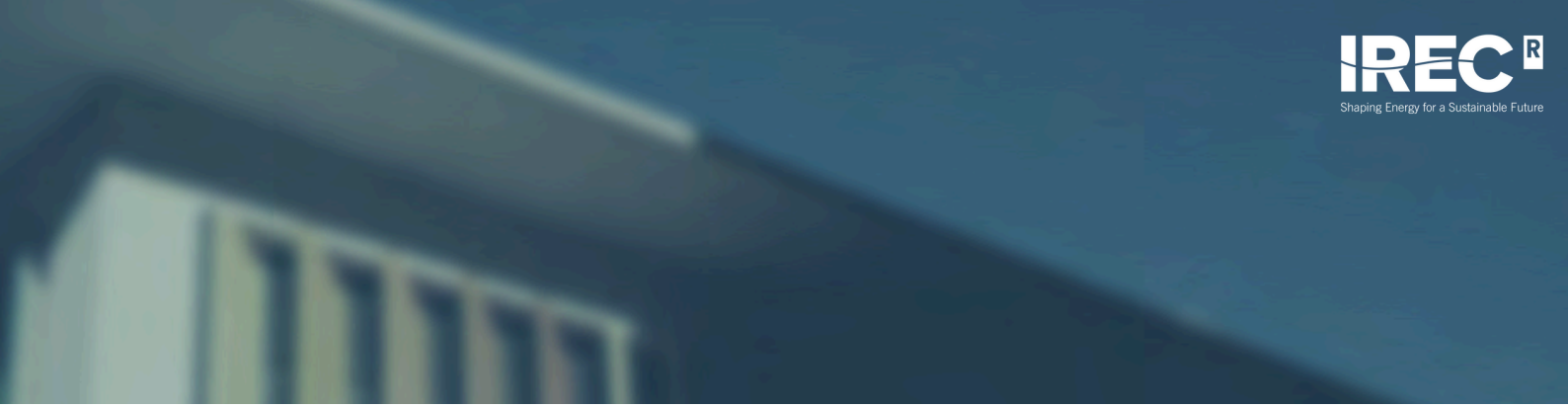
DESIRED PARTNERS

- System integrators
- End-users

EXPECTED BENEFITS

- Fast charge-discharge
- Higher stability and safety
- High-temperature operation
- Can be miniaturized

technical details



INNOVATION SOLUTION

Lithium-ion (Li-ion) batteries are the most popular battery option available today. Representing more than 90% of the global grid market, they are used in plenty of fields and applications. However, limitations such as current lithium shortages, limited range of operating temperatures, degradation over time and environmental hazards associated to its extraction and end-of-life are drivers that encourage the development of other battery systems based on other materials.

In particular, Li-ion batteries are not suitable for high-temperature applications due to capacity fading (70% capacity loss at 60 °C) and safety issues. The high-temperature oxygen ion battery represents a game-changer for the field of portable batteries, as it can operate continuously in a range of temperatures between 150 °C and 400 °C, without the need for cooling systems. Based on an **all-solid-state architecture**, the technology can be adapted in size and capacity for a number of applications, from harsh industrial setting to geothermal and aerospace.

KEY ELEMENTS

This technology is a rechargeable battery based on oxygen ions. Oxygen ions are accumulated and exchanged between two electrode layers which are separated by a solid electrolyte. The two electrode layers and the electrolyte are made of oxide ceramic materials that are stacked on top of each other. Thin film deposition techniques may be used for the fabrication of the battery. The operational temperature is 150°C - 400°C, with a voltage up to 1 V and high stability in harsh environments.

Patent number WO2023213905

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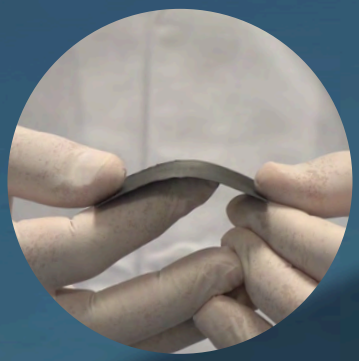

THERMOELECTRIC NANOSTRUCTURED FLEXIBLE FABRICS

FOR HYDROGEN SENSING, THERMAL RUNAWAY DETECTION AND POWER GENERATION

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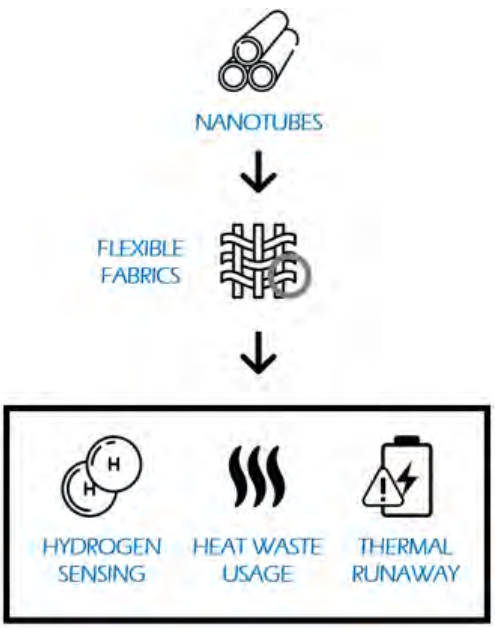
THE CONCEPT



ADDED VALUE

- Adapts to any hot surface
- High performance
- Good mechanical properties
- Self-powered

TRL

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PRODUCT DESCRIPTION

- **Thermoelectric flexible fabrics** made of nanotubes which can **adapt** to any hot surfaces
- Very **light** and **thin**
- Based on non-toxic and abundant raw materials
- Uses waste heat to function
- Flexible, light, and highly stable at high temperatures
- Can be mass-produced at **low-cost** with already existing manufacturing industrial processes
- Application in a sensitive self-powered thermoelectric **hydrogen sensor**

APPLICATIONS

- Energy harvesting from heat waste
- Power IoT nodes in industrial environments (industry 4.0, chemical industry, petrochemicals or automotive sector)
- Hydrogen sensor
- Thermal runaway sensor in electric vehicles or second-life batteries storage

DESIRED PARTNERS

- Industrial partners, IoT manufacturers, system integrators
- Battery manufacturers
- Companies using large-scale CVD

EXPECTED BENEFITS

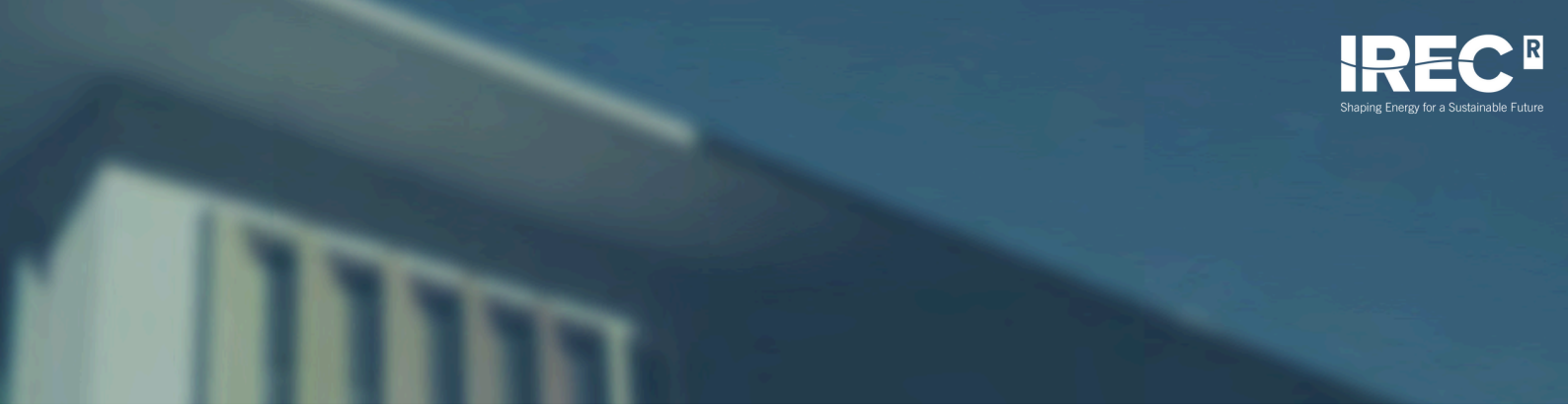
Self-powered devices

Low-cost, large area production

Flexible material

Environmentally friendly

technical details



APPLICATION DETAILS

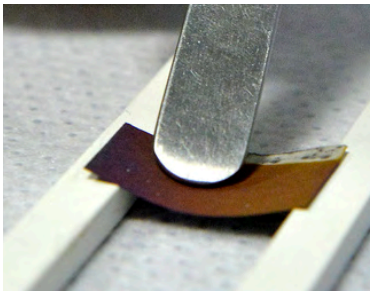
The silicon nanotubes combine the high electrical conductivity of silicon with limited thermal conductivity thanks to its nanostructured nature to obtain the highest figure of merit possible.
It has been tested and fabricated in IREC's laboratories, and the production process employs well established mass manufacturing techniques like electrospinning and CVD. Other relevant features that arise from the material's architecture are its lightness, the ease with which it adapts to multiple geometries, its flexibility and the stability that it has, even at high temperatures (700°C).
A self-powered hydrogen sensor has been fabricated by depositing a catalyst on the fabric, which triggers the oxidation of hydrogen, locally releasing heat. This heat is then converted into power. It is capable of detecting up to 250 ppm of hydrogen at room temperature. This technology can be used for thermal runaway detection in batteries, since hydrogen is released during this process.

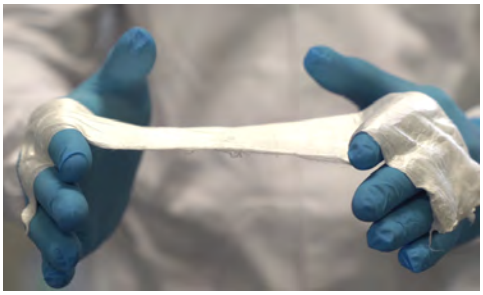
THERMAL RUNAWAY DETECTION

Battery safety is becoming more important due to the growth of the battery market. Before an explosion occurs, hydrogen is released and our technology could detect the hydrogen released during the thermal runaway and so prevent hazardous consequences. The ultra-low current consumption and the high rate of diffusion of hydrogen are an advantage compared to current solutions, since its reliability is not expected to depend on its position relative to the triggered cell.

The main figures of merit of this hydrogen sensor are:

- **Limit of detection**: 250 ppm at RT, 50 ppm at 100 °C
- **Selectivity**: Demonstrated selectivity towards CH_4 and DME
- **Response time**: 40 s at RT, 15s at 100C
- **Power density generation**: 0.5 μW cm^{-2} at RT and 2.75 μW cm^{-2} at 100 °C





Adaptable to any surface shape

Patent number: EP3306685

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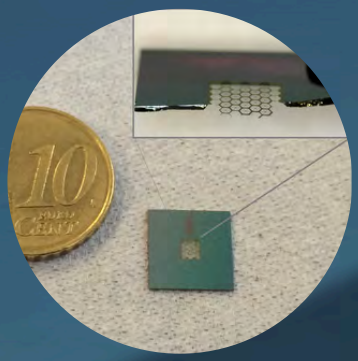

IREC
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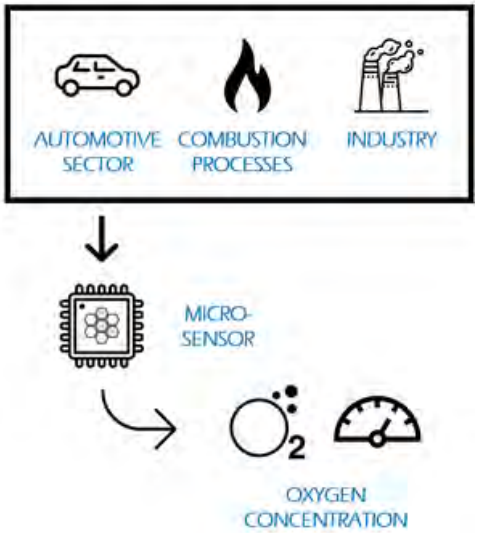
COST EFFECTIVE MICRO-OXYGEN SENSOR

TECHNOLOGY FOR A CLEANER TOMORROW

THE CONCEPT



ADDED VALUE

- Improves energy efficiency of burners
- Reduces fuel consumption and environmental impact
- Miniaturized low-cost sensor

TRL

4

PATENTED

CONTACT

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PRODUCT DESCRIPTION

A **customizable micro-fabricated** zirconia-based **sensor** which provides a fast and stable response to different **oxygen** concentrations. It comprises a nanometric membrane and self-heating elements, everything integrated in less than 1 cm^2.

Microfabrication techniques, added to the know-how of the group, allow to **adapt the design** of the sensor to any space constraint.

APPLICATIONS

- Industrial gas boilers
- Industrial combustion processes
- Automotive sector

DESIRED PARTNERS

- System integrators,
- Boiler manufacturers
- Automotive sector distributors

EXPECTED BENEFITS

Reduction of harmful emissions

Large-scale low-cost production

Small volume

Response time in the range of milliseconds

technical details

SPECIFICATIONS

The sensor incorporates self-supporting membranes of ceramic materials with nanometric dimensions. These membranes are separated by silicon nerves with a double function: on the one hand, they confer stability to the film of active material. On the other, they serve as a support on which heating elements are integrated. The latter will provide a very fast and efficient heating since they are very close to the active element. At the same time, its electricity consumption will be almost negligible due to the small dimensions to be heated. The sensor is fabricated using silicon microtechnology.
The technology allows an almost instantaneous heating (ca. 2s) thanks to the miniaturization and the integration of the heating elements, which will remain active in any condition. Current sensors need longer (30-40s) to reach their optimum operating temperature. Likewise, the small volume it occupies means that the sensor can be placed in a variety of locations. As additional advantages, energy consumption will be small and the manufacturing cost is much lower, thanks to the large-scale manufacture using microfabrication techniques.
The same technology can be used to add functionalities to the sensor, such as multigas or temperature sensing, by replacing certain materials or changing the design somewhat.

MICROFABRICATION

The use of microfabrication technology allows getting possibly the smallest potentiometric oxygen sensor in the market which will allow its location in places of difficult access nowadays.
At the same time, these reduced dimensions will enable its fabrication in mass production conditions; therefore, a great decrease in the manufacturing expenses is anticipated. These two facts would allow improving the combustion process control via an optimum location of the sensor and more redundancy (since more sensors could be allocated for the same price and space).

PERFORMANCE

The performance of the sensor has been tested in laboratory environments where the device chemical response, cyclability and stability have been evaluated positively.
Proof of concept devices with integrated heater have demonstrated good operability under very diverse conditions with negligible energy consumption.

Patent number: P201331791

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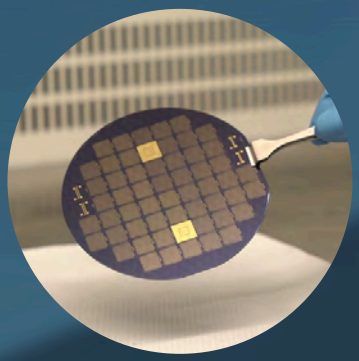

IREC
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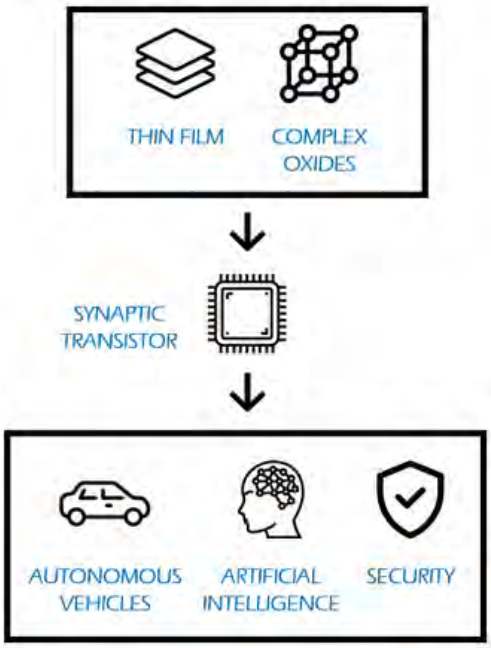
SYNAPTIC TRANSISTORS FOR NEUROMORPHIC COMPUTING

BASED ON NEW GENERATION SOLID STATE IONIC CONDUCTORS

THE CONCEPT



ADDED VALUE

- Analog and non-volatile synaptic behavior
- Robust and stable

TRL

4

PATENTED

CONTACT

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PRODUCT DESCRIPTION

- **Three-terminal synaptic transistor** based on solid oxide thin films
- Mimics the **efficient operation of our synapses**
- Analog and non-volatile modulation of channel's conductance is achieved through voltage-controlled oxygen ion insertion
- Advanced electrolyte allows oxygen ion movement at **low temperature**
- BEOL compatible with **traditional microelectronic industry**
- Potential to be substantially more efficient than traditional transistors

APPLICATIONS

- High demand computing applications: AI, autonomous vehicle, image recognition, language understanding
- Microelectronic sector, i.e. neuromorphic and stochastic computing, non-volatile memories for data storage
- Magneto-ionic switching

DESIRED PARTNERS

Semiconductor industry, microelectronic integrators, Silicon intellectual property and design houses, SW/HW designers, and integrated device manufacturers.

EXPECTED BENEFITS

- Multilevel synaptic transistor and memory
- Compatible with semiconductor industry
- Non-volatile elements
- Independent of atmospheric conditions

technical details

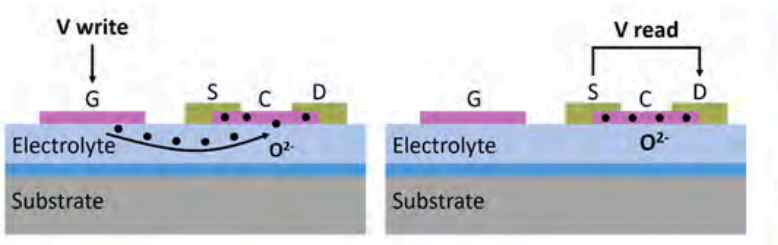
INNOVATION SOLUTION

The technology, inspired by nature, is a synaptic transistor or a non-volatile memory based on a solid oxide ion gating to be applied to neuromorphic computing.
Its nonvolatile and analog characteristics allow to overcome traditional von Neumann architecture for future in-memory computer design. The use of oxygen ions for the modulation of channel's conductance overcome the limitations on stability and integration of current synaptic transistors. The main disruption of this technology is the solid oxide-ion thin film electrolyte able to work at low temperature. This feature opens the door to a full new range of applications in microelectronic sector, such as autonomous vehicles, diagnosis or security.

MAIN BENEFITS

- Three terminal transistor that mimics the behavior of human synapses
- The analog and non-volatile behavior permits in-memory design, overcoming traditional von Neumann computer's architecture
- High data storage and high efficiency for reducing energy consumption of emerging applications, such as AI
- Exploiting oxygen ions to modulate transistor's conductance ensure the operation in any atmospheric condition
- Large operation temperature range is possible thanks to the superior oxygen ion conductivity of the thin film

WORKING PRINCIPLE



IMPLEMENTATION

A proof of concept demonstrated for multistage process system based on solid oxide ionics.

Patent number WO2022263659

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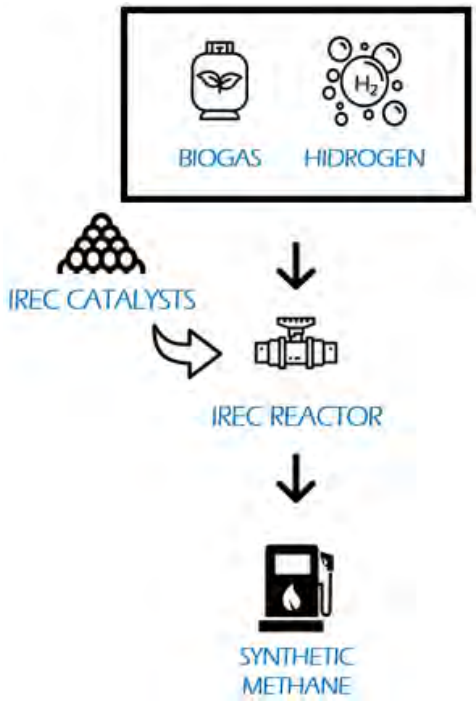
SYNTHETIC NATURAL GAS PRODUCTION

TO CONVERT CARBON DIOXIDE INTO RENEWABLE NATURAL GAS

THE CONCEPT



ADDED VALUE

- Lower upfront and operational costs
- Tolerance to impurities

TRL

6

PATENTED

CONTACT

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PRODUCT DESCRIPTION

- Designed and constructed an in-house **catalytic chemical reactor** prototype for **methanation**
- Developed own catalysts to convert **carbon dioxide** into **renewable natural gas** to increase the efficiency of the reaction into methane
- The reactor works **autothermally**, reducing reliance on external energy sources: increases the reactor energy efficiency and reduces the costs
- The process produces synthetic natural gas of quality **equivalent to natural gas** from the grid

APPLICATIONS

- Biogas or combustion fumes valorisation
- Gas vehicle mobility
- Injection of synthetic gas into natural gas grid
- Chemical storage of renewable energy
- Valorisation of CO_2- circular economy with GHGs reduction

DESIRED PARTNERS

- Reactor engineering companies
- End-users, such as energy industry/companies/utilities
- Investors or accelerators

EXPECTED BENEFITS

Catalyst 25 % more active

60 % reduction in CO_2 emissions

Lower CAPEX/OPEX

Easily scalable

technical details

KEY ELEMENTS OF THE INNOVATION

- Autothermal methanation process that uses the heat generated by the methanation reaction to maintain the optimal temperature for the catalytic process
- Flexibility to work with different biogas composition and volume flowrates
- The catalyst is tailored for (micro)reactor specifications (0.2–3 mm), with porosity (100–200 m^2/g) and optimized metal loading (10–25%) for efficient biogas applications.

CARBON RECYCLING

- Production of synthetic fuels from carbon of biogenic origin or by reuse of carbon dioxide and water
- Feasible incorporation of hydrogen to the current gas grid by its conversion to methane
- Use these synthetic fuels as a large-scale energy storage that allows to increase the share of non-fossil-source energies
- Development of a circular economy around carbon dioxide emissions contributing to its effective reduction through the use of a closed loop of carbon of biogenic origin
- Energy interconnection between the electricity and gas networks, and promotion of new options and opportunities for the development of new energy models
- Use of biomass and other sources of waste with organic content such as sewage sludge and/or slurry contributing to environmental improvements

IMPLEMENTATION

Catalysts and autothermal reactor validated in biomethane pilot plants in real conditions, using other infrastructures and own technology: Waste water treatment plant (EDAR, Sabadell), Energy lab 2.0 KIT (Karlsruhe), waste management plant in Mas Barberans (Tarragona).

Methanation unit in EDAR (Sabadell)

Biomethane reactor in Mas Barberans (Tarragona)

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IREC
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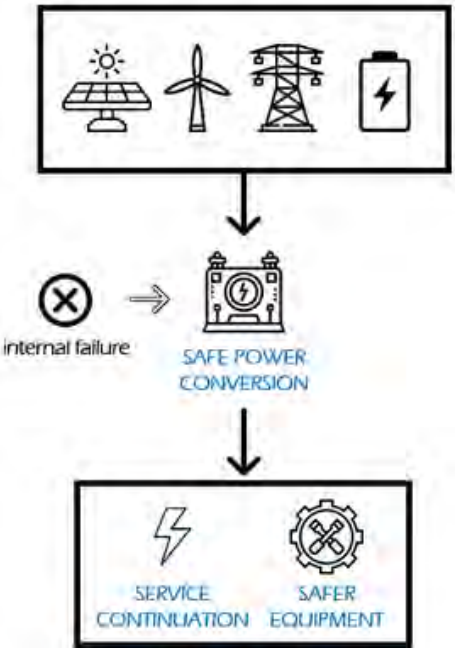
VERSATILE AND RESILIENT POWER CONVERTER

TOWARDS A SYSTEM BASED ON RENEWABLE ENERGY

THE CONCEPT



ADDED VALUE

- Reliable electrical network in remote areas
- Security and quality of the service

TRL

5

PATENTED

CONTACT

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PRODUCT DESCRIPTION

- **Power converter** adapted to handle **renewable energy** efficiently: from generation, storage to the electrification and integration of new vehicles
- **Fault-tolerant** converter: Remains in operation after any of its internal component fails, thanks to its redundant internal structure and reconfiguration hardware
- Minimizes redundant components
- It **reduces** considerably the initial **capital investment**, as well as the **costs of implementation and maintenance**

APPLICATIONS

Our power electronic converters:

- Can replace redundant equipment by our fault-tolerant systems
- Can be implemented in remote areas
- Makes implementation of electric vehicles, renewables, management and batteries for storage more feasible

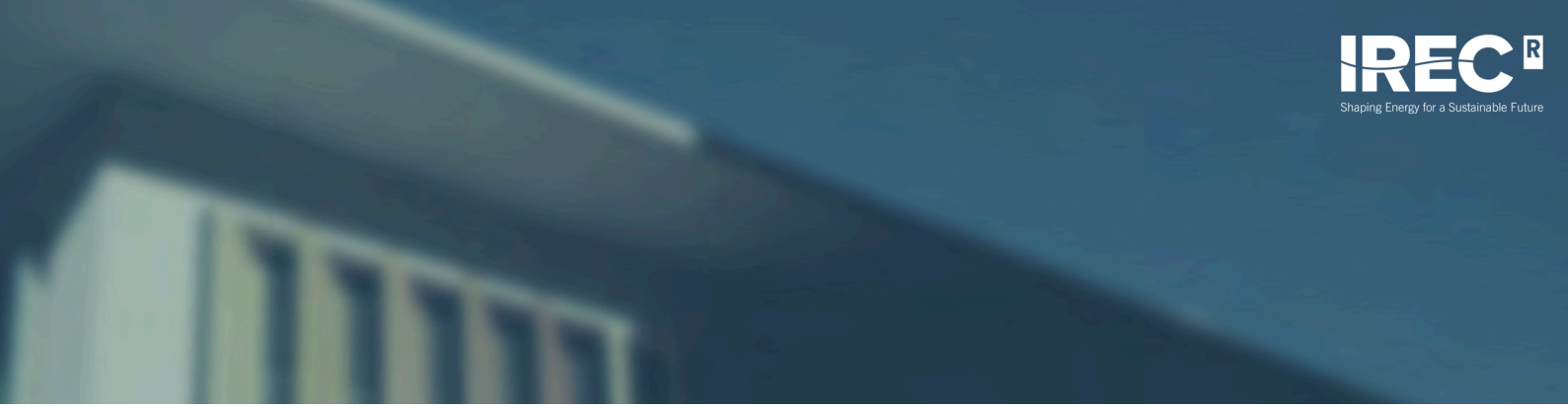
DESIRED PARTNERS

Industrial partners in the field of power electronics and investors.

EXPECTED BENEFITS

- 40% capital cost reduction
- Reliability of the electrical network
- >50 % extended lifespan
- Implementation of renewables

technical details



COMPETITIVE ADVANTAGE

The technology provides several advantages comparing to current solutions, such as the cost reduction, the reduced energy losses due to system failure, increasing the O&M time to repair of the equipment (allowing continuous operation under such conditions) and an extended lifetime. This technology is based on a new internal configuration of the semiconductor-based switches which compose the power converter, and also the redundant components can be used for both converters DC/DC and DC/AC, unlike other cases.
With the appropriate management system, higher levels of resilience, efficiency and operational capacity can be achieved. The internal reconfiguration of the system in case of failure or change of operation is automated when a series of indicators are detected leading to isolate the faulty component and maximizing the efficiency of the device during its operation.

MAIN BENEFITS

The system is based on a new internal configuration of semiconductor-based switches on the power converter. With the appropriate management, higher resilience, efficiency and operational capacity can be achieved.

Our innovation has the following benefits:

- **Capital cost reduction**: We estimate that our system will save 40% of the cost compared to redundant systems. The proposed fault-tolerant converter is about 5-10% more costly than no-fault tolerant inverters (without redundancy). However, including a redundant converter implies almost double the capital investment.
- **O&M cost reduction**: By including the additional components, the system may continue operating although a failure occurs, reducing maintenance needs.
- **Life Extension**: The lifetime will be increased. In preliminary analysis, the structure without redundancy got 3.53 years at continuous full-load condition operation meanwhile the proposed concept got 7.65 years.
- **Efficiency**: Similar in both technologies.

Patented number: EP4214824A1

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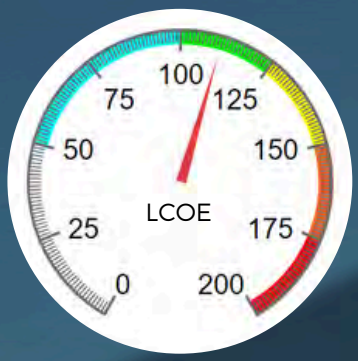
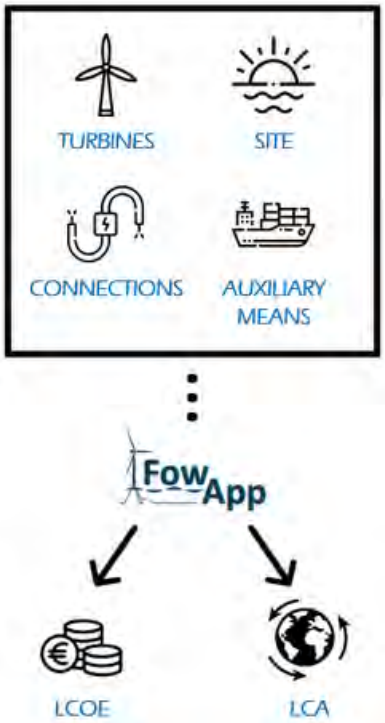


FOWAPP

FLOATING OFFSHORE WIND ASSESSMENT APP

THE CONCEPT



ADDED VALUE

- Transparency of input and output data used for calculations

TRL

5-6

REGISTERED

CONTACT

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PRODUCT DESCRIPTION

- **Desktop application** to compute the **Levelized Cost of Energy** (LCOE) and to perform a detailed **Life Cycle Assessment** (LCA) of **floating offshore wind farms**
- The software calculates all the intermediate results such as wake or grid energy losses
- **Includes a library** for the user inputs, such as site specifications, components or auxiliary means
- Designed to be intuitive and user-friendly

APPLICATIONS

Focus on **floating offshore wind farms**:

- Early project development
- Technology assessment
- Environmental impact evaluation
- Performance analysis

DESIRED PARTNERS

Project developers, specialised engineering companies, consultancies and data aggregators.

EXPECTED BENEFITS

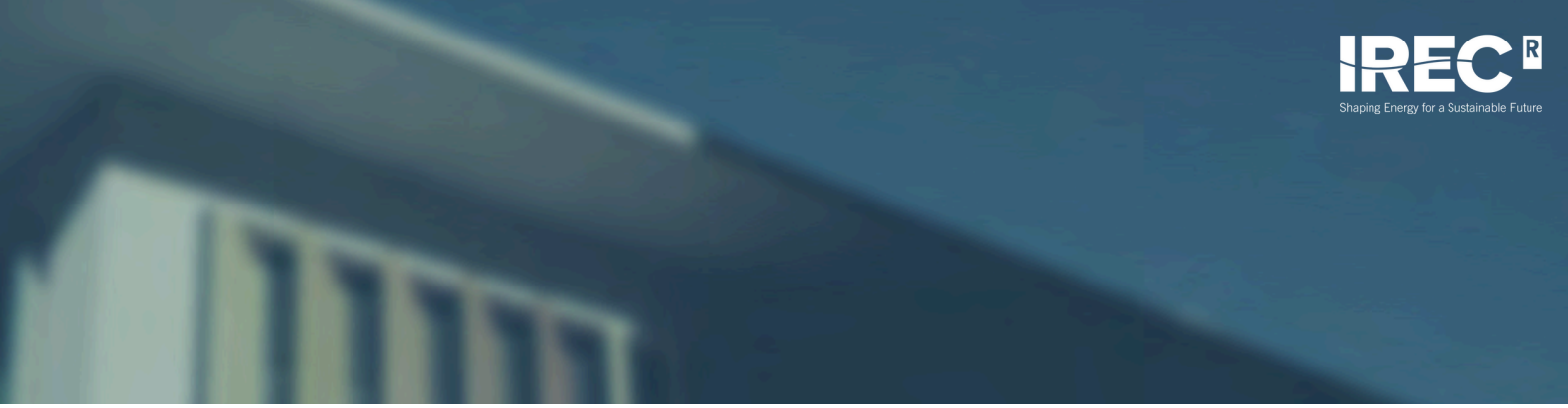
User-friendly/ Usability

Quick and reliable results

Overall scenario overview

Costumizable by user

technical details



FEATURES

FowApp is:

- built specifically for the floating wind industry
- developed using a well established software
- storing all the information, except the images, in an SQLite database
- capable to import data from MS Excel
- complete, integrating electrical power flow and wake calculations
- detailed from the technical perspective
- offering a full project overview using a relatively easy to use App

INPUT DATA

The app includes a library where generic information is stored, such as site definitions, components (wind turbines, cables, substructures, anchors, etc.) and auxiliary means details (cranes, vessels, helicopters, etc.). On the other hand, any number of projects may be defined, using information of the library plus additional details such as the layout, electrical connections and the life cycle process (design, construction, O&M and decommissioning).

OUTPUT DATA

Three main results are obtained and combined to get the LCOE and LCA:

- the AEP (Annual Energy Production)
- the LCC (Life Cycle Costs)
- the associated environmental impacts of the following categories:
  - Global Warming Potential (GWP)
  - Abiotic Depletion Potential Elements (ADPe)
  - Primary Energy Demand (PED)
  - Acidification Potential (AP)
  - Eutrophication Potential (EP)
  - Aquatic Toxicity Potential (ATP)
  - Human Toxicity Potential (HTP)

LCC = CAPEX + OPEX + DECEX

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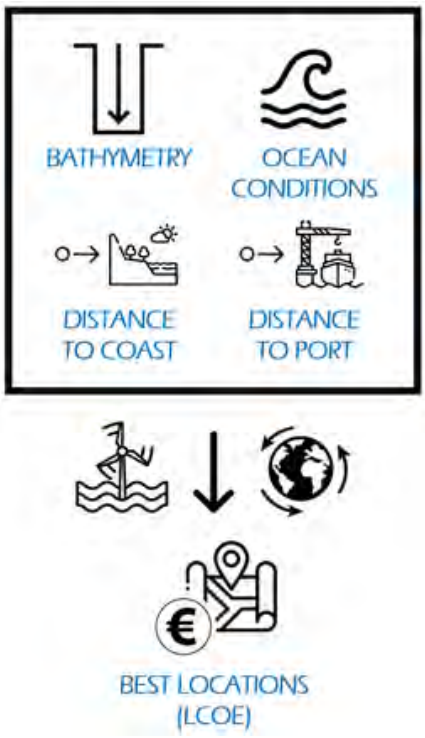
WORLDWIDE DATA-BASE FOR OFFSHORE WIND LCOE

TO BOOST THE IMPLEMENTATION OF FLOATING OFFSHORE WIND ENERGY

THE CONCEPT



ADDED VALUE

Demonstrates the viability and areas of interest for potential projects

TRL

4-5

CONTACT

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PRODUCT DESCRIPTION

- **Global world-wide dataset and map** of the LCOE for the construction of **floating offshore wind parks**
- Based on internal calculations using critical parameters
- Includes the associated **development costs** and highlights the **most suitable areas**
- Uses **publicly available** data
- Can be adapted to include additional datasets; Carbon footprint analysis following the LCA methodology is currently being implemented
- Delivers a very easy to use, very easy to read data
- Power delivery performance calculations have been used as a reference for energy output

APPLICATIONS

Helps to initiate the spatial analysis of potential floating windfarms to have an overview of the best areas.

DESIRED PARTNERS

- Floating offshore wind park developers and constructors
- Public administration
- Strategic infrastructures' decision makers

EXPECTED BENEFITS

Easy to use

Global approach

Cost analysis

Helps implementation

technical details

ADDITIONAL DETAILS

In its development, variable cost factors have been considered based on bathymetry, ocean conditions, distance to the coast, and distance to port. Power delivered to the onshore grid has been used as a reference for energy output, rather than turbine production.

The level of detail is complex, as the tool utilizes databases of all the ports worldwide. The analysis was performed at the Exclusive Economic Zones, 200 nautical miles from the coast, and depths ranging from 60 to 1000 meters of water, with a resolution of one arc minute. The delivered data has fairly good precision.

Regarding Levelized Cost of Energy (LCOE) values, average results for different floating concepts supporting a 15 MW turbine in a 300 MW wind farm are represented, identifying many areas with costs below €100/MWh.

This map is available for consultation under an open license at floatingwindmap.energysmartlab.com. Commercial use is restricted.

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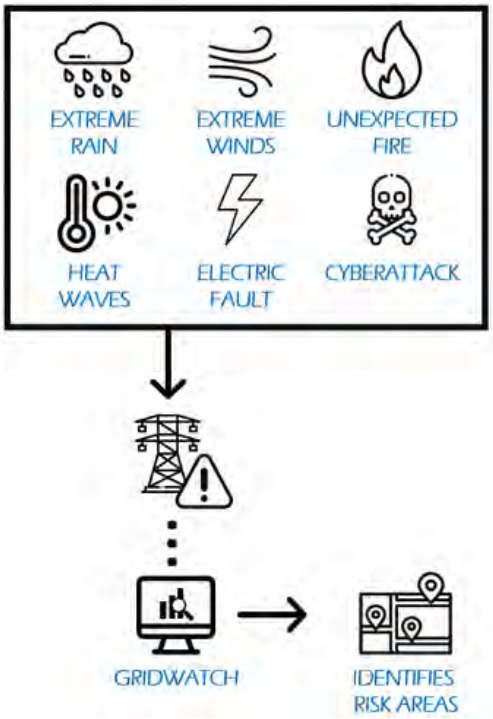
GRIDWATCH TOOL

ASSESSES RISKS IN THE ELECTRICAL NETWORK AND IMPROVES ITS RESILIENCE

THE CONCEPT



ADDED VALUE

- Maintains the energy supply on the grid
- Increases preparedness for future extreme events

TRL

REGISTERED

7

CONTACT

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PRODUCT DESCRIPTION

- **Analytical tool** that deals with **risk areas of the power grid** under extreme weather events or external threats
  - **Detection of vulnerabilities** of the grid and assessment of potential future risks of network failure using available datasets
  - **Risk assessment in real time** using sensors and drones on-site
  - **Mitigation of the risk** using a self-healing approach, such as reconnection and sectorialization in microgrids
- Predicts certain weather impacts on elements of the grid
- **Fault location** of the electrical grid using **machine-learning** techniques
- Computes the **optimal electric scheme** of the grid to isolate problems and continue the operation
- Can be tailor-adjusted to any grid utility

APPLICATIONS

- Electrical distribution planning
- Risk prevention and awareness
- Reinforcement of the electrical grid
- Application of preventive measures
- Solving electrical faults, cyberattacks to grid elements and other emergencies affecting the grid

DESIRED PARTNERS

Electric utility companies

EXPECTED BENEFITS

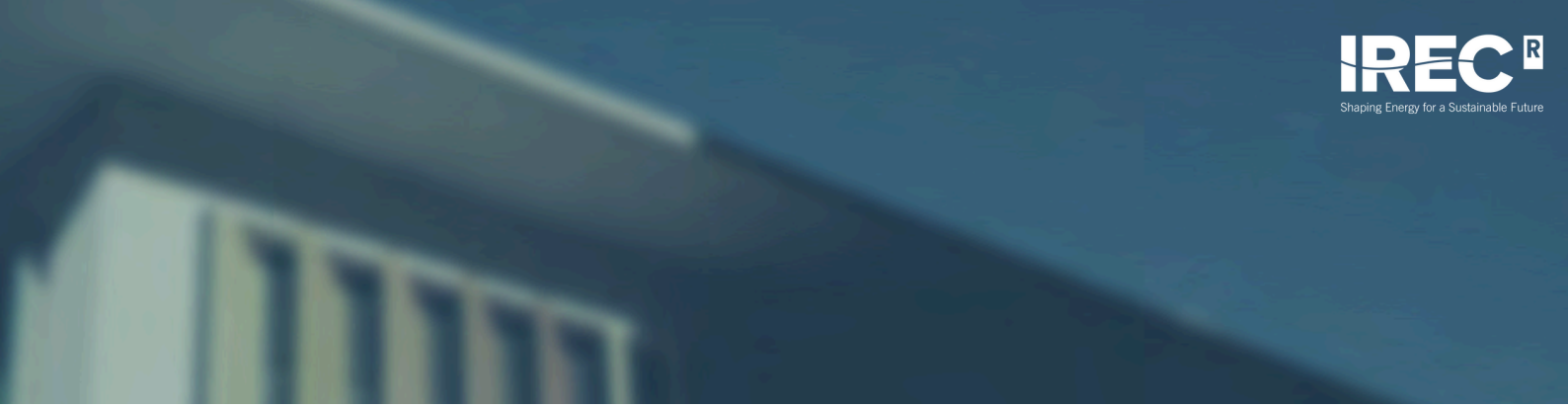
Reduction of risks

Low cost of implementation

Versatile tool

Grid resilience

technical details



CURRENT FUNCTIONALITIES

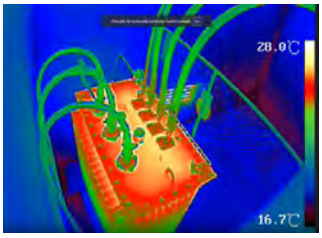
Gridwatch integrates in one single tool, different functionalities that can be tailor-adjusted for each grid need, involving:

- Electrical system risk statistics
- Fault location of the electrical grid using machine-learning techniques
- Self-healing mechanism: minimizes the negative impact on energy supply and maximizes system resilience through grid reconnection and sectorialization in microgrids
- Assessment of electric assets at ground level exposed to flooding risks
- Electric lines assessment for high exposure to extreme wind currents, exposed to high potential breaking hazard
- Zonal assessment of extreme temperatures and dense vegetation conducted to forecast fire-prone areas
- Implementation of a fire alarm system to detect areas with major wildfire risk through the installation of fire detectors. It involves fire assessment, overheat and algorithm improvements
- Connection with external tools such as Copernicus, weather online, local meteorological stations, and other, to gather weather forecast data
- Weather impact to the elements of the grid such as Dynamic Thermal Line Rating and the calculation of the aerial line elongation
- Can incorporate new functionalities that could be of interest for users, such as integrations with REST APIs and MQTT connections

IMPLEMENTATION

Validated in pilot tests in **Barcelona, Bristol , Salzburg** and **Rhodes** (for the extreme weather events feature), in **IPTO grid**, Greece (healing in a large-scale islanding scenario), in **Estabanell grid**, Spain (healing cyber-attacks), and in **e-Distribución grid** in Doñana National Park, Spain (for heat waves feature)

Real-time data collection (Doñana)



In-situ analysis of thermal overheat in grid elements (e-Distribución)

Cyber-attack feature validated in Estabanell grid

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CASE
THE DEMAND AGGREGATOR

MONETIZE THE FLEXIBILITY OF ANY ASSET

THE CONCEPT

ADDED VALUE

- Modular architecture
- Consumer in the center of the energy system
- Capacity to manage all distributed resources

TRL

6

TRANSFERRED

CONTACT

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PRODUCT DESCRIPTION

- **Software platform** for demand aggregators
- **Demand aggregators** are the **new market actors** that enable demand side **response** and **flexibility** to participate in energy markets and grid services
- Provides advanced technological **solutions** to **monetise** demand management and **flexibility** of energy assets and allows the **integration** of **renewable** energy sources

APPLICATIONS

- Distributed energy resources
- Energy markets
- Local energy communities

DESIRED PARTNERS

Industrial and commercial partnerships to demonstrate CASE technical and economic feasibility: energy retailers, aggregators, ESCO's, EV fleet managers.

EXPECTED BENEFITS

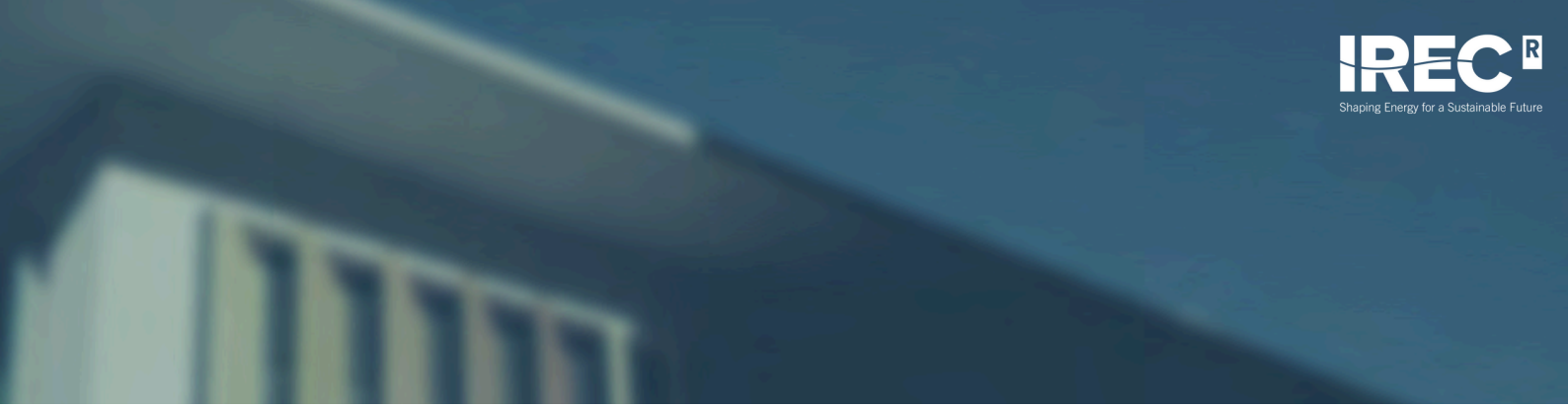
Reduces energy cost

Sustainable corporate image

Scalable (cloud-based)

Increased efficiency

technical details



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INNOVATION SOLUTION

CASE software platform offers a customized and flexible solution to independent aggregators and retailers to efficiently manage distributed flexibility resources. CASE improves the aggregator operation using artificial intelligence, sophisticated mathematical models and cloud computing. CASE is able to forecast market condition, consumption and flexibility using information gathered from smart buildings and distributed energy sources to make the best decision for the aggregator and the end-user benefit. CASE was born to provide a holistic tool for the operation of demand aggregators, providing optimal flexibility management in a variety of scenarios. At its core, it relies on the combination of advanced machine learning techniques to predict the flexibility of its clients' portfolio and the market conditions, robust mathematical modelling and optimization algorithms for optimal portfolio management and behavior analysis. These characteristics are not present in any other aggregator software solution in the market.

MAIN FUNCTIONALITIES

- **Market forecast:** predicts prices in different electricity markets for the next day
- **Load Forecast:** three different algorithms tested over four different type of consumption (residential, tertiary building, industry and district), validated over real data
- **Flexibility Forecast:** predicts the flexibility of various appliances (PV, HVAC or batteries)
- **Bidding optimization:** optimizes the day-ahead aggregator bidding strategy in different markets, taking into account the load, flexibility and market forecasts
- **Intraday optimization:** schedules in real time the flexibility resources, makes a follow up of the flexibility activations and eventually redispatches flexibility
- **Observability and data analysis:** the consumer can monitor its consumption and its flexibility, providing economic and environmental indicators.

IMPLEMENTATION

Applied in 3 pilot demonstration projects at laboratory scale and 2 pilots working 24/7 under real conditions. Validated in: Tirant lo Blanc library (Montgat) and a pre-commercial program.

Technology licenced to Bamboo Energy

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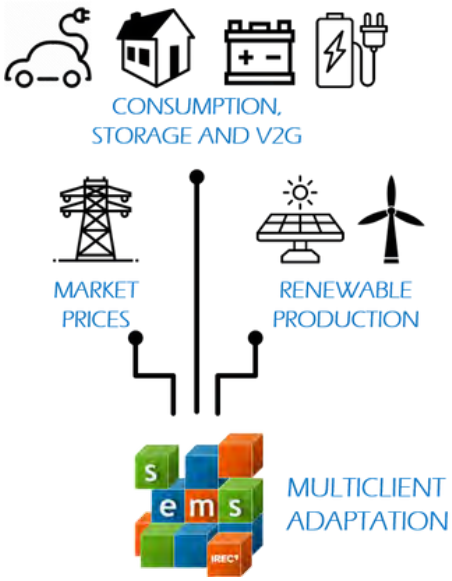
SEMS- SMART ENERGY MANAGEMENT SOLUTION

A PRODUCT FOR OPTIMIZING ENERGY USAGE

THE CONCEPT



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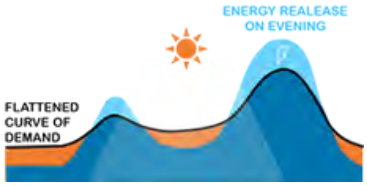

TRL

7-8

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TECHNOLOGY DESCRIPTION

- **Hardware and software solution** for the smart and dynamic energy management of self-consumption solutions
- Able to include **multiple types of consumption** and generation units, energy storage systems, as well as electric vehicle charging infrastructure or vehicle-to-grid systems
- Offers the necessary **intelligence** to find the **optimal operation** of the system, to minimize energy costs, energy consumption peaks and emissions, all autonomously and automatically

APPLICATIONS

- Microgrids
- Buildings with several energy assets (consumption, storage, electric vehicles...) and e-parkings
- Local energy communities

DESIRED PARTNERS

- Entities requiring smart energy management

EXPECTED BENEFITS

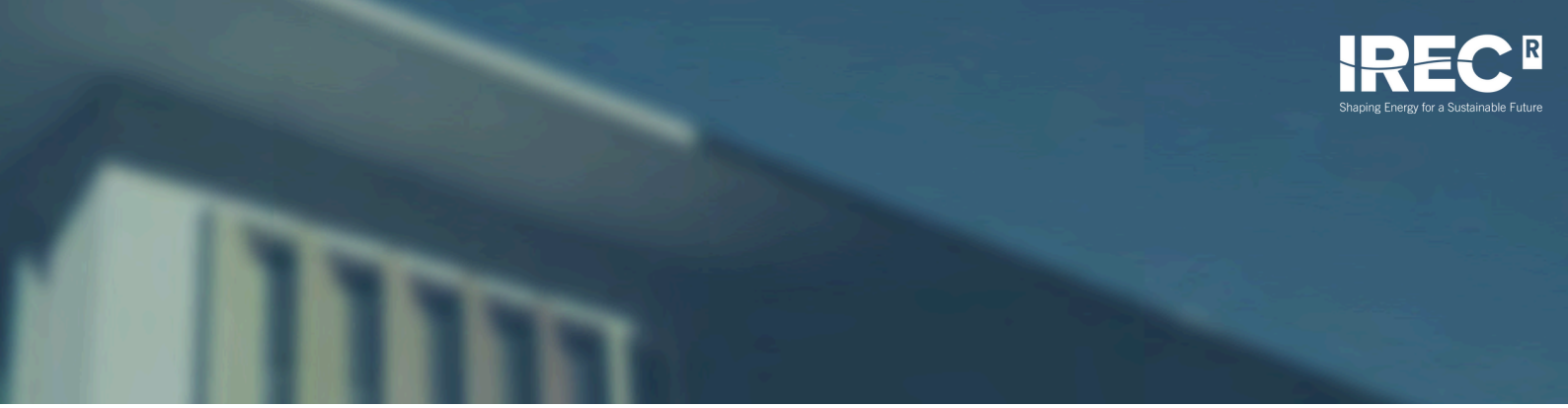
20 % increase in energy storage use

10-15 % reduction in energy bills

peak shaving

8-10 % increase in self-consumption of RES

technical details



SOLUTION INTELLIGENCE

- Machine learning for the forecast of energy demand and forecast of use of electric vehicle chargers.
- Mathematical optimization for the energy management of the different resources at 24 hours.
- Download weather and energy price curves.
- Real-time control for adjustments to unforeseen events.
- Open system for Demand Response services activations.

MONITORING SYSTEM VIA SCADA

- Historicization of the information collected from devices.
- Configurable notification system, by SMTP to any desktop or mobile device, that includes alarms and events generated by physical equipment.
- Configurable reporting (web or RTF, XML, PDF, HTML, and CSV...).
- Remote access to the application for real-time viewing, maintenance and retrieval of data.
- Calculation of indicators for operation, economic savings, CO_2 emissions and peak power.
- Management system configuration.
- Management of user profiles and rights within the monitoring screens.

PROTOCOLS / COMMS

- Configurable drivers to communicate with PLCs, remote I/O devices, and other data-acquisition equipment: MQTT, API REST, Modbus TCP, Client and server, SNMP, MODBUS, RTU/ASCII, CAN/CAN Open, IEC 60870-5-104.
- Connect to SQL databases (MS SQL, MySQL).

IMPLEMENTATION

Installed in 3 pilots working 24/7. Interoperability already validated in 9 commercial systems with different communication systems: SMA - SCHNEIDER - FRONIUS - EATON/NISSAN - Circutor WallBox - WallBox ENEL - MAGNUMCAP - FASTO

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3D MODELLING OF URBAN AREAS

METHODS AND TOOLS TO PLAN CLIMATE NEUTRAL DISTRICTS

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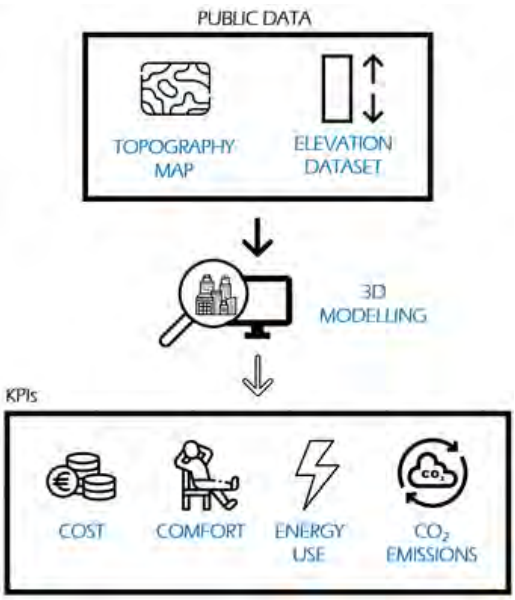
THE CONCEPT



ADDED VALUE

- Based on OGC standard CityGML
- Procure for automatic generation of windows
- Potential expansion of calculation modules

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6-7

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PRODUCT DESCRIPTION

- Methods and tools designed to **generate 3D models** of **large urban areas**
- Uses a large amount of **publicly available data**, such as **topographic maps** and **elevation datasets**
- Adapted to the **Spanish cadaster**
- Can predict the **impact of urban actions** taking energy efficiency, environmental, economic and social factors into account
- Capable to deliver and visualize **key performance indicators** to support **decision-making processes**, such as primary energy, CO2 emissions, economic and consumption balance, LCA, energy certificates or comfort

APPLICATIONS

- Help decision-makers in urban regeneration
- Residential retrofits at district scale
- Energy transition planning
- Environmental impact assessment
- Generation of digital twins for urban areas and cities

DESIRED PARTNERS

- Town councils and public companies
- Urban planning companies and promoters
- Environmental and energy consultants

EXPECTED BENEFITS

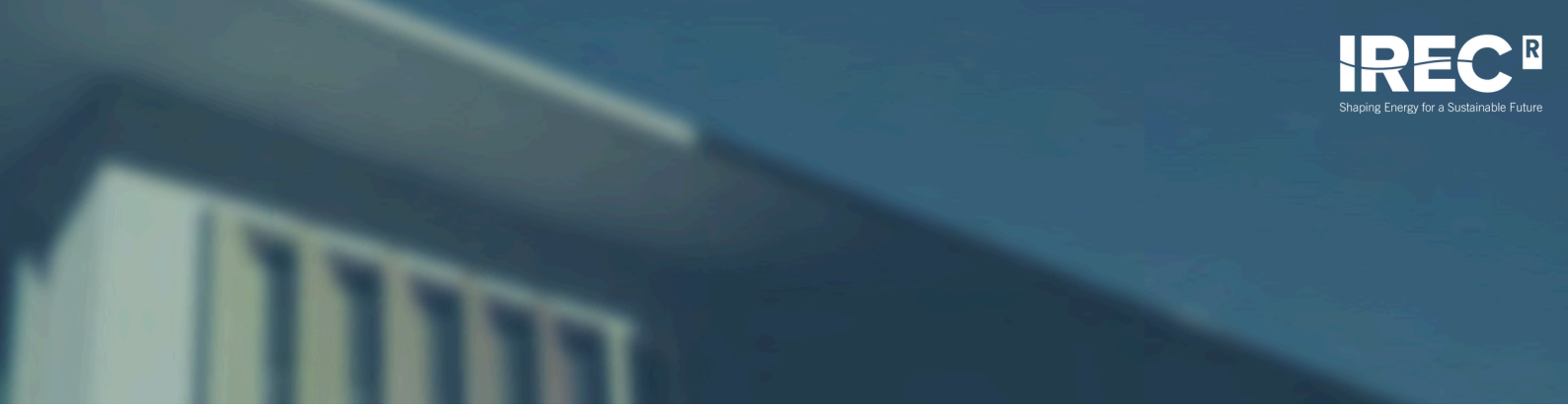
Personalized outputs

OGC standard format

User friendly

3D visualization

technical details



INNOVATION SOLUTION

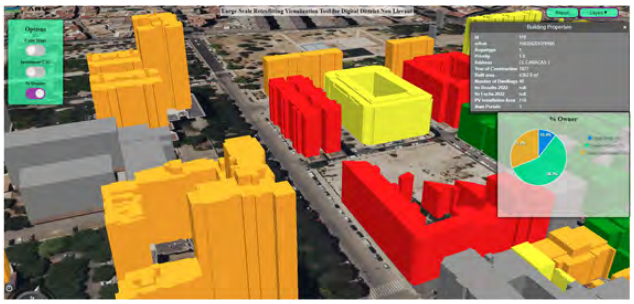
A set of methods and specific own produced software tools allows obtaining 3D geometries of neighborhoods in CityGML standard, developed by Open Geospatial Consortium. The CityGML standard defines a conceptual model and exchange format for the representation and exchange of virtual 3D city models. It facilitates the integration of urban geodata for Urban Digital Twin.
The virtual representation of cities is used for various purposes, in the context of planning urban actions. In addition, the 3D models can connect to customizable calculation modules that offer insights on energy and environmental performance, as well of economic costs at district level.

TECHNICAL DETAILS

- Through public data (2D cadastre in .shp format + LIDAR in .las format) the 3D model of the buildings is generated with the open-source software 3dfier in .OBJ format. The own specific code developed in Python stores the geometric data of buildings (walls, roofs and floors) from .OBJ format in PostgreSQL database with postGIS extension in a specific form in order to be exported later through the 3DCityDB in CityGML format
- The generated code works as input with the .OBJ format, which allows flexibility in the definition of the geometry because many 3D generation and modelling software can work with it
- 3D geospatial visualization of data using CesiumJS

IMPLEMENTATION

This technology is being tested and is under refinement in several urban areas, as for example the Districte Innovació Llevant in Palma (Spain).



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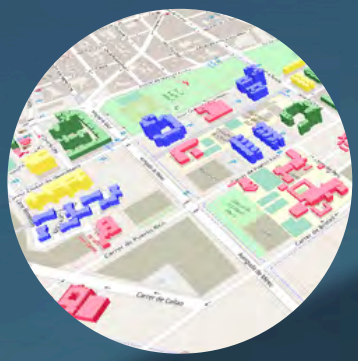
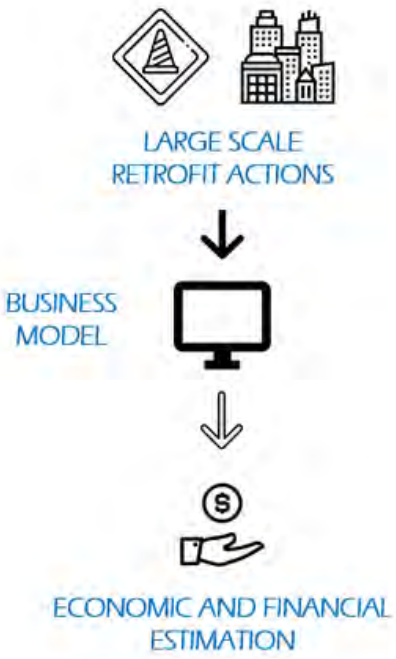


BUSINESS MODEL FOR RESIDENTIAL RETROFITS AT DISTRICT SCALE

IREC Shaping Energy for a Sustainable Future

ECONOMIC AND FINANTIAL INFORMATION FOR RETROFITTING ACTIONS

THE CONCEPT



ADDED VALUE

- Unique tool for large-scale retrofitting actions
- Helps decision-makers

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PRODUCT DESCRIPTION

- **Business model tool** to support reliable predictive **economic and financial large-scale retrofitting actions** under **Private Public Partnership** (PPP) frameworks
- Quantitative evaluation
- Analysis of the **critical elements** of the operation for the different types of end-users
- Tool targets large retroffiting actions ranging from 150 – 500 dwellings in several buildings (10-50) in a district

APPLICATIONS

- Tool for large-scale residential retrofitting
- Financial analysis and implementation support tool for retrofitting agents
- Strategic analysis of retrofitting actions of the building stock for municipalities

DESIRED PARTNERS

Private and SME stakeholders (e.g. investors, real estate agents, retrofitting managers, urban planners, construction companies), public sector (e.g. municipalities, regions, city councils) and end-users.

EXPECTED BENEFITS

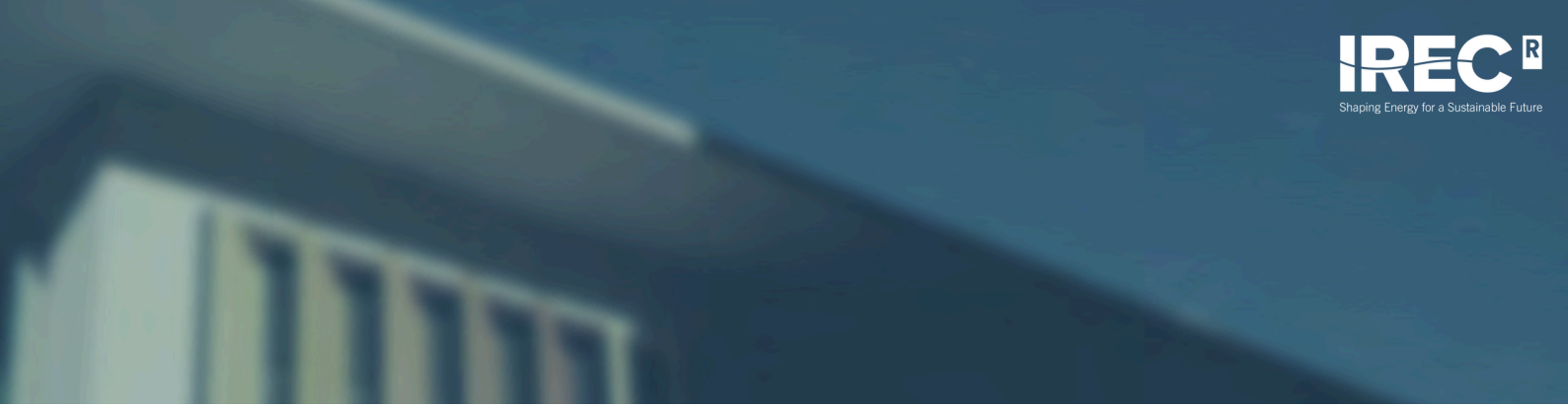
Large-scale actions

Quantitative evaluation

Customizable by stakeholders

Analysis of critical elements

technical details



INNOVATION SOLUTION

The new tool is programmed in Python programming language and is useful to evaluate several strategies for the renovation of existing building stock. It moves from a quick list of input according to several Public Private Partnership models, in addition to other potential business models. Furthermore, the design of the model is supported by a step-by-step methodology in order to deal with a financial appraisal that is interactive in each context, customizable for each stakeholder, and user-friendly. This innovative tool has a stronger potential when it runs in a GIS-based software environment and interacts with a PostgreSQL database, as demonstrated in two case studies located in Spain.

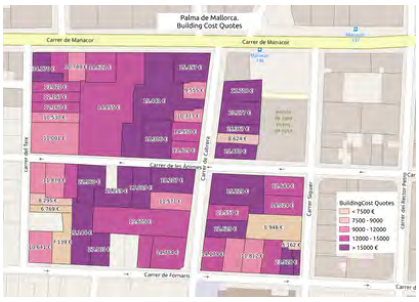
KEY ELEMENTS

The most critical parameters can be analysed in a sensitivity analysis around a defined case base. The model computes a set of indicators as results of the analysed area and a set of parameters / variables which can be set depending on the case. The model works in Python with aggregated data for evaluating potential business model scenarios.
Several PPP business models can be considered (e.g. Retrofitting agent, Turnkey, Public) by customizing some of the parameters in the model.
The indicators are economical and financial conditions for the:

- End users: monthly quote, end-user savings
- City council: city operational costs; revolving fund size
- Retrofitting manager: operational costs, benefits, financial costs and financial needs.

IMPLEMENTATION

Applied and validated in two case studies. Under deployment in pilot areas in Palma de Mallorca and other districts in Italy, Austria, Portugal and Spain.



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ALMMA

ALGORITHMS FOR MONITORING AND THE MANAGEMENT OF HVAC SYSTEMS

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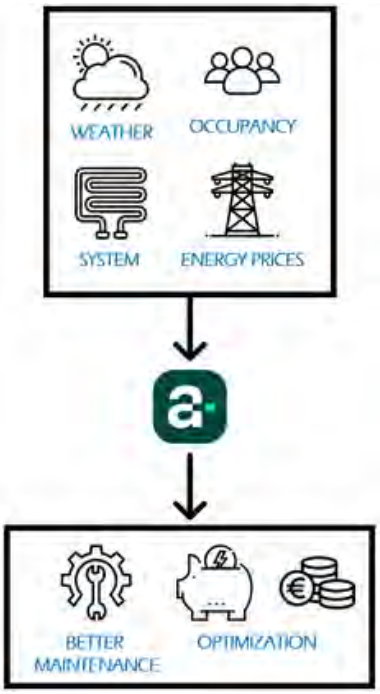

ADDED VALUE

- Optimization balancing comfort-cost-environment
- Increased lifetime of equipment

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PRODUCT DESCRIPTION

- Two complementary control algorithms improve operation and performance of heating and cooling systems
  - **Fault detection and diagnosis (FDD)** algorithm assesses heat pump performance and identifies anomalies to reduce energy and operational costs
  - **Model predictive control (MPC)** enables to plan and operate heat pumps or other HVAC systems in an optimal way based on external inputs
- Takes into account the specificities of the system, short-term forecasts of weather, occupancy and prices
- Possible to integrate with existing platforms

APPLICATIONS

- Heat pumps
- Flexible heating and cooling loads
- Control and operation of HVAC systems

DESIRED PARTNERS

Heat pump manufacturers, facility managers, aggregators of flexibility, owners or constructors of buildings, developers of energy management systems

EXPECTED BENEFITS

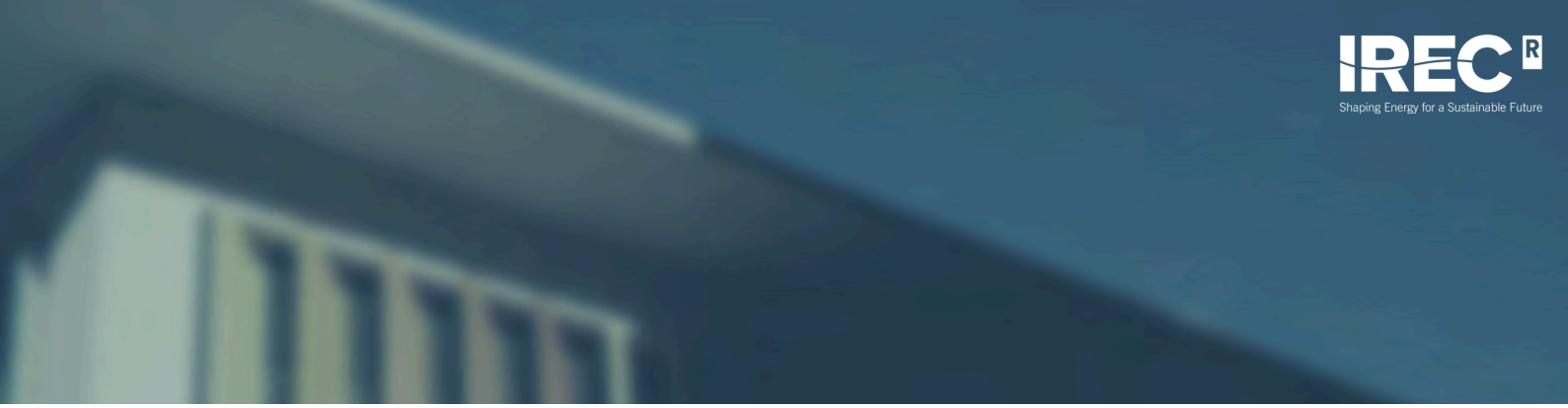
20-30% energy savings

Fault detection

Improved thermal comfort

30% reduction of energy bills

technical details



KEY ELEMENTS OF PREDICTIVE CONTROLS

Predictive and price-driven rule controls reduce energy costs and environmental footprint of heating and cooling. It uses simplified models to predict the behavior of the system and defines the optimal energy management strategy for heating and cooling. The input data is the forecast of weather, energy market prices and occupancy in the building, so that the predicted scenario consider future boundary conditions. The developed solutions manage thermal mass of the buildings to enhance energy flexibility. In addition, the algorithms are able to include solutions of active demand-side management through existing protocols like Smart-Grid ready or OpenADR, to enable direct connection to flexibility aggregators.

KEY ELEMENTS OF FAULT DETECTION

Automated fault detection and diagnosis techniques can prevent the deterioration and identify possible faults, which leads to savings in energy, service and operating costs. Our solution uses machine learning to learn the behavior of the heat pump. A constant monitoring of the heat pump measurements ensures that any deviation from normal operation is detected and diagnosed, using the default sensors that comes with the heat pump.

IMPLEMENTATION

Collaborations with industry: HITACHI/Johnson Controls - BAXI - EPRI, Naturgy- Schneider Electric. Solutions validated in lab environment and in a real residential building for the management of centralized domestic hot water systems.

Heat pump in our testing lab

Demo case in the Llevant Innovation District in Palma de Mallorca

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BUILDING REDUCED ENERGY MODELS

INTELLIGENT ALGORITHMS FOR NEXT GENERATION POSITIVE BUILDINGS

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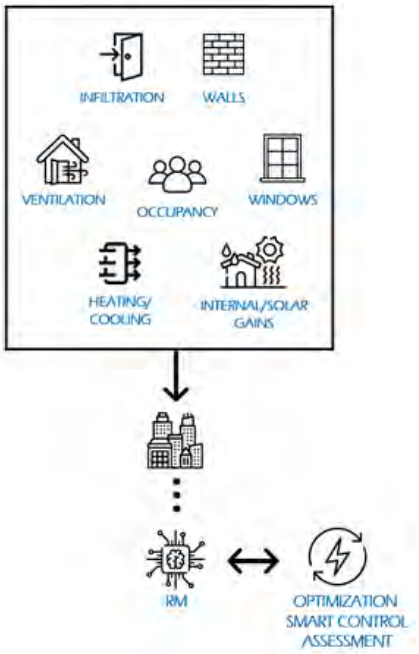

ADDED VALUE

- Complex phenomena are simplified
- Lower computational time
- Easy to integrate with existing platforms/devices

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PRODUCT DESCRIPTION

- **Simplified building behavior algorithms** that predict the energy profile using few resources
- The reduced models (RM) define the key parameters able to **explain and forecast** the energy demands and consumption behaviour
- Can be **adapted** to various cases, ready to be implemented in existing technologies or devices
- Can predict the **user behaviour** and **user interaction** with the building
- **Assessment** and **predictive maintenance** of technologies

APPLICATIONS

- New or retrofitted tertiary and commercial buildings
  - Semi-automated energy audits (energy layers of eBIM)
  - Dynamic recommendations to users (edge computing)
  - Model predictive control for optimal management (BEMS 5.0)
  - Manage building flexibility at district level (PEB/PED)

DESIRED PARTNERS

- Monitoring devices producer
- BIM developers
- BEMS developers
- District tools producers
- DSO and utilities.

EXPECTED BENEFITS

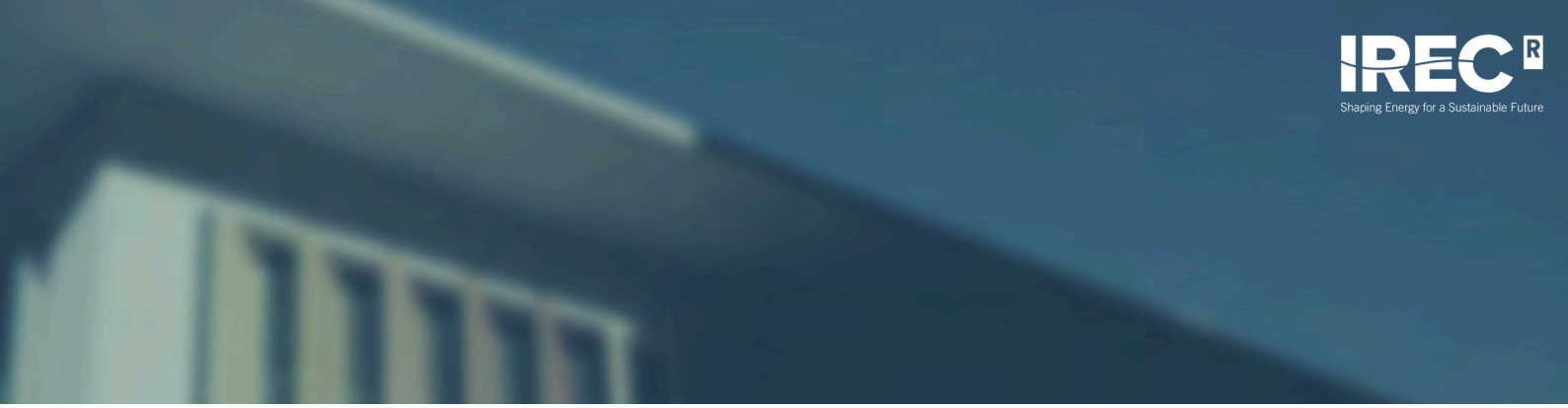
20-30% energy savings

30-50% cost reduction

Improved thermal comfort

Optimized maintainance

technical details



MOTIVATION

In a context of change towards the decarbonisation of the economy, the building sector faces gigantic challenges, both in the building stock and in newly constructed buildings. The Green Deal and the renovation wave establish the way forward that requires a new generation of tools and methodologies capable of meeting the planned challenges in the shortest possible time, the least use of resources, and putting the end user in the main focus.

Intelligent design, management and operation of buildings is a capital pillar in the strategy for the reconversion of the building sector, which should allow for optimized renovations in terms of cost and consumption, efficient use of existing buildings, and new flexible buildings as part of positive energy districts. In this context, the use of Resistances and Capacitances (RC) models, integrated into targeted products and services within RM, ensures maximum reliability of results at minimum cost of resources, and offers a set of new market services with broad commercial potential.

KEY ELEMENTS

- RM aims to equip intelligent existing devices and tools which will be able to take profit on the new IT advancements (5G)
- RM evolved from reference ISOs to different precision levels
- Based on up to 17 characteristic parameters of buildings; the models use 6 transitive input variables to obtain the thermal zones behaviour
- RC models could be easily adapted to case, through calibrated white models or monitored data sets
- Easy scripts based on matricial formulation to be adapted to any platform
- Heating, cooling and free-floating modes availability, with temperature RMSE between 0.15 -0.80 °C
- Fit with real data from short-term (minutes), to medium-term (weeks), even for free-floating conditions

IMPLEMENTATION

Validated in real buildings for **tertiary** (office, sport centres) and **residential** uses, taking into account different climate conditions (**continental - Mediterranean**).

Residential (Terrassa, Spain)

Office buildings (Manresa, Spain)

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STOCHASTIC MODEL FOR ENERGY DEMAND

FROM OCCUPANCY BEHAVIOUR, ELECTRIC CONSUMPTION AND DOMESTIC HOT WATER

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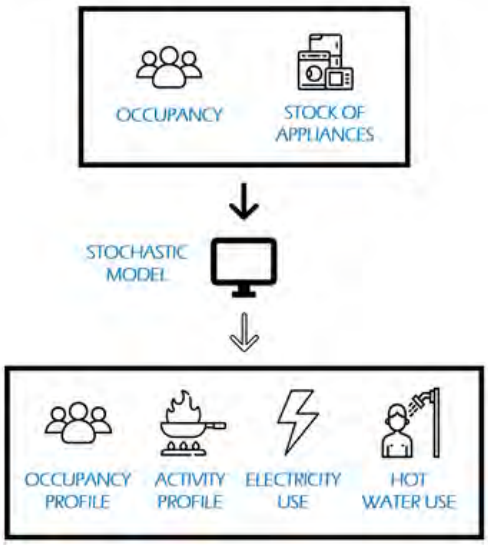
THE CONCEPT



ADDED VALUE

- Specially adapted to Mediterranean climate
- Easy integration with other simulation tools

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PRODUCT DESCRIPTION

- Stochastic model that generates **occupancy patterns, electric consumption** related to electric devices and **domestic hot water profiles for residential buildings**
- Profiles with a **high time resolution**
- Able to **reproduce realistic households** with different occupancy levels and electric devices.
- Implemented in **TRNSYS**, as a Type/Subroutine coded in Fortran.

APPLICATIONS

Set of profiles/data available on request, for applications in:

- Positive energy districts and neighbourhoods
- Electrical grid optimisation
- Renewable energy systems integration

DESIRED PARTNERS

- Urban planners
- Building designers
- Energy consultants

EXPECTED BENEFITS

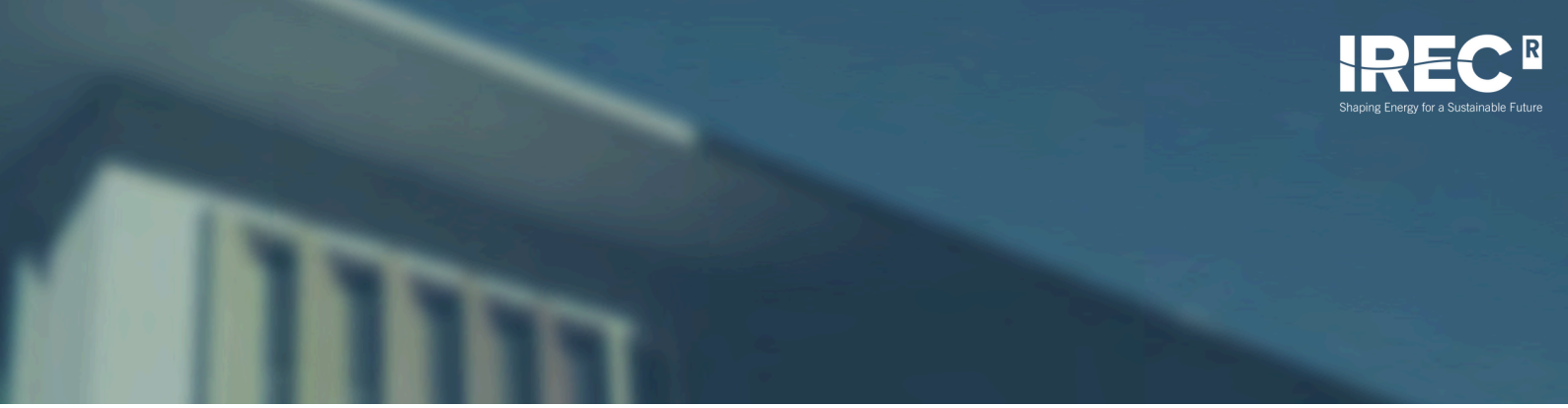
Realistic households

Flexible methodology

High resolution

Detailed information

technical details

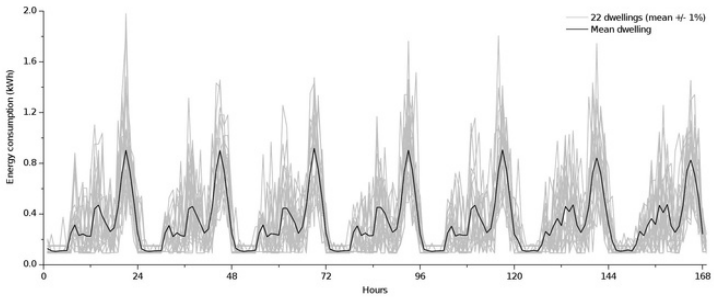


ADDITIONAL DETAILS

Modelling user behaviour and its interaction with household systems is a challenge to reduce the gap between simulation and reality. The hypotheses of occupancy could have an important effect on energy and peak power estimation, making the validity of simulation limited. In the framework of building performance analysis through simulation, the occupancy behaviour, the electricity consumption caused by appliances, and the operation of the heating and cooling systems have usually been based on daily and/or weekly profiles. This approach has some strong points when the focus is to evaluate the performance of the building envelope and the heating and cooling supply systems. However, it has not shown to be useful when a detailed characterization of the household consumption is needed, as for example when studying the interactions with the grid in a "prosumer" building. From this perspective, a solid modelling approach to evaluate grid interaction, peak power values, demand side management strategies and design of positive energy districts and energy communities should comprise both high-resolution time step models together with stochastic occupancy and electrical devices consumption models.

KEY ELEMENTS

- The model is implemented in TRNSYS, as a Type/Subroutine coded in Fortran
- High-resolution: 3-min
- Occupancy, electricity and domestic hot water profiles as a result of the tool
- A flexible methodology that can be adapted to different scenarios:
  - Different occupancy levels (1, 2, 3 or 4 occupants)
  - Different stock of appliances and energy performance
  - Different occupancy scenarios (for example related to pandemic restrictions)
- Adapted to Spanish behaviour



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UPENERGY

APP TO CENTRALIZE AND MONITOR YOUR ENERGY USAGE

THE CONCEPT

ADDED VALUE

- Promotes efficient use of energy in companies and the administration
- Facilitates networking and mutual learning

TRL

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PRODUCT DESCRIPTION

- **Mobile App** that works as an **energy calculator** for all home energy consumptions
- The engine sorts **all the energetic information**, and easily displays daily, weekly, monthly and yearly consumptions per sources
- Based on bills and meter information (both electrical and thermal sources) and end-user self-characterization. Can incorporate real **data from Datadis**
- **Tailor-made suggestions** oriented to **end-user** and **cluster groups**
- Cluster benchmarking & group competitions to save energy

APPLICATIONS

For residential end-users through companies and public bodies, to get:

- Detailed knowledge of the energy consumptions sorted by sources and in a regular time-scale
- Oriented to user energy savings recommendations and tips
- Groupal contents to save energy through gamification scenarios
- Cluster benchmarking for smart comparisons

DESIRED PARTNERS

Local to supramunicipal public bodies, small to large companies, NGO and non-profit organizations.

EXPECTED BENEFITS

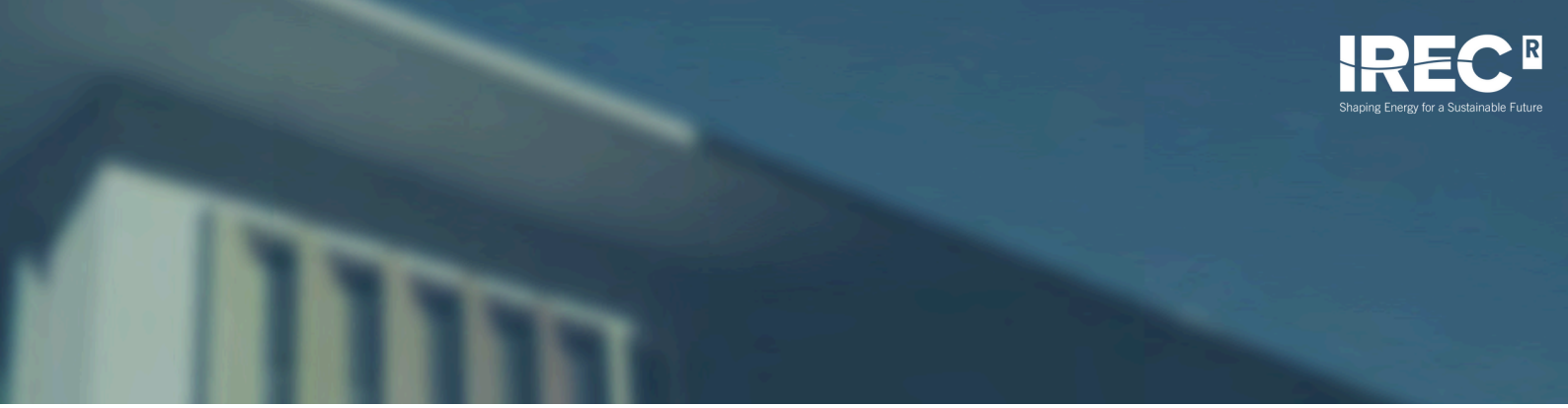
Easy to understand

Clustering of users

Creates a network

Reduces CO_2 footprint

technical details



FUNCTIONALITIES OF THE APP

- Characterization of the user through the definition of energy sources and consuming elements in the home
- Characterization of the user through access to their energy consumption data via billing and/or access allowed to Datadis
- Graphics of consumption according to different metrics and time periods
- Comparison of own consumption
- Comparison of consumption with third parties
- User-oriented energy saving recommendations
- Common and group energy saving challenges

PROGRAMMING DETAILS

- Open code "React native" Framework, in java script
- Backend: Python, bash and SQL
- App downloaded in Android/IOS
- CRM (web): Windows, Mac and GNU/Linux
- Uses Open Source data
- Database: PostgreSQL

IMPLEMENTATION

Energy communities within the Osona region (Catalonia), Xarxa de Dones Cosidores (Barcelona) and CIC have been beta-testers of the App.

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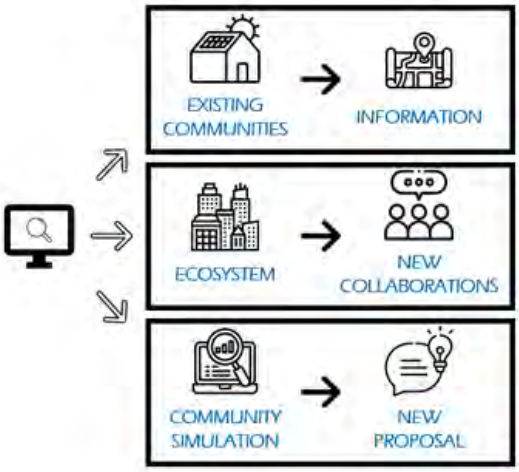
COMUNITAT ENERGÈTICA

A WEB PLATFORM TO SCALE-UP ENERGY COMMUNITIES IN YOUR TERRITORY

THE CONCEPT



ADDED VALUE

- User -friendly
- Tailored for each potential user

TRL

9

CONTACT

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PRODUCT DESCRIPTION

- Web platform that promotes **energy communities** deployment
- Stands out for its **simulation engine** of PV collective self-consumption for **residential and tertiary sectors**, and under consumer to prosumer modes
- Helps to discover initiatives, connect with key stakeholders, and access targeted resources
- Oriented to **different actors** (citizens, associations, professionals, administrations)
- Can be tailor-adjusted for **any region world-wide**
- Based on 4 fundamental **pillars:** Energy communities repository, stakeholders repository, PV simulator and open resources

APPLICATIONS

Related to energy communities in residential and tertiary buildings:

- Territory repository
- Simulation of scenarios in new locations
- Creation of new connections

DESIRED PARTNERS

- Regional to national public bodies
- Consultancy groups
- Research entities

EXPECTED BENEFITS

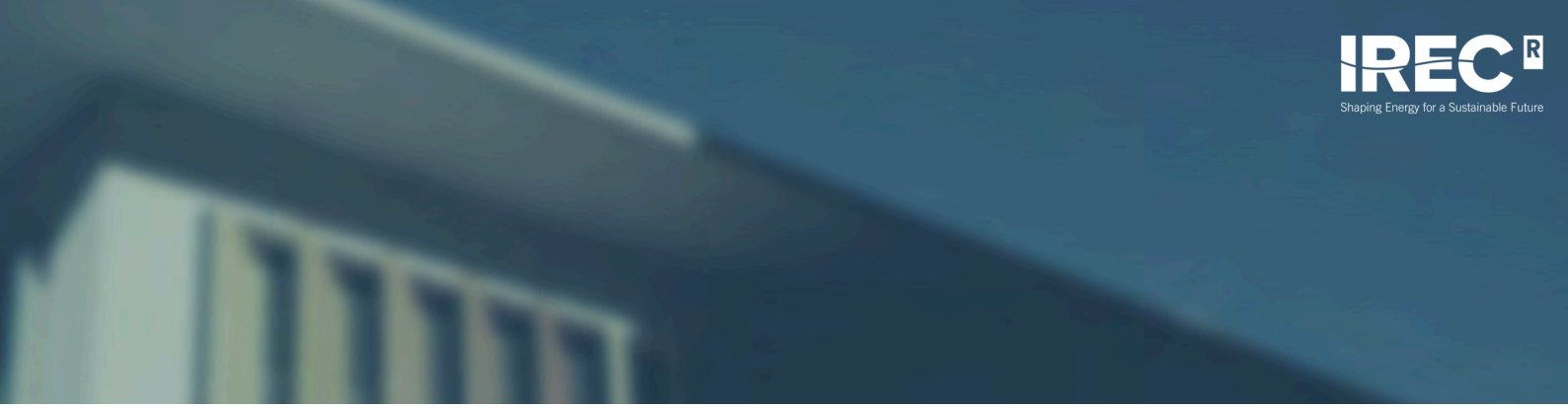
Beyond existing tools

Optimal user experience

Large-scale analysis

Powerful modelling

technical details



INNOVATION SOLUTION

Comunitat Energètica is a tool that enables the deployment of energy communities throughout the territories. Based on detailed, automated modeling, the platform is presented as a **layered tool** that can offer **targeted information** for **different stakeholders** (individual users, associations, public administrations, and companies in the sector), with special attention to providing an optimal user experience. Beyond the operational features focused on energy sharing through photovoltaic installations, the platform will offer functionalities to exploit the **broader concept of energy services**, including the potential for building renovation and the potential for heat exchange based on district heating and cooling networks.

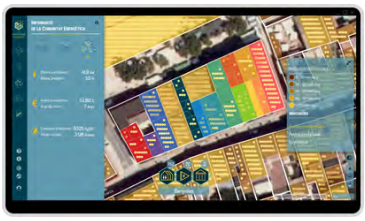
TECHNICAL DETAILS

The platform goes beyond the various tools existing on the market by delivering:

- **Volumetric characterization** of the building stock, and its orographic environment, in an automated manner based on cadastral data.
- **Automated sizing**, with the option of detailed characterization by the user, of the potential for installing PV panels on the roofs
- **Multiple users** can be considered (producers, consumers, prosumers)
- Modeling scenarios based on an **hourly calculation engine**, providing energy and economic results on an hourly basis or aggregated monthly or annually.
- **Detailed calculations** based on an optimized combination of stored data and detailed cloud simulations, in a process based on optimized runtime

IMPLEMENTATION

The **official platform of *Generalitat de Catalunya*** to promote energy communities (validated for 1.4M buildings). All climate conditions and building uses are considered.



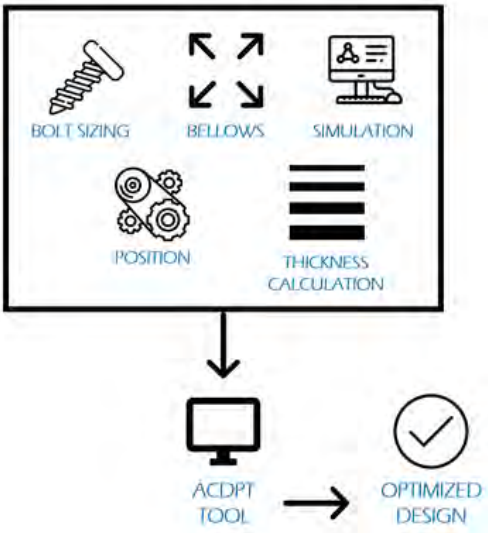
https://comunitatenergetica.cat

Some icons used in this catalogue are extracted from https://www.flaticon.com/

FUSIONCAT-ACDPT TOOL

ACCELERATOR COMPONENTS DEVELOPMENT AND POSITIONING TOOL

THE CONCEPT



ADDED VALUE

- Helps the commissioning activities
- Integrated codes and standards validation
- Multi stage design

TRL

5-6

REGISTERED

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PRODUCT DESCRIPTION

- Tool to perform calculations related to the design of **accelerator** and **fusion-related mechanical components**
- Determines and validates designs of such components using **different industry standards** and **methods**
- Uses widely known codes and standards, brought together for the first time for accelerator components design

APPLICATIONS

Design of components for:

- Particle accelerators
- Fusion-related components

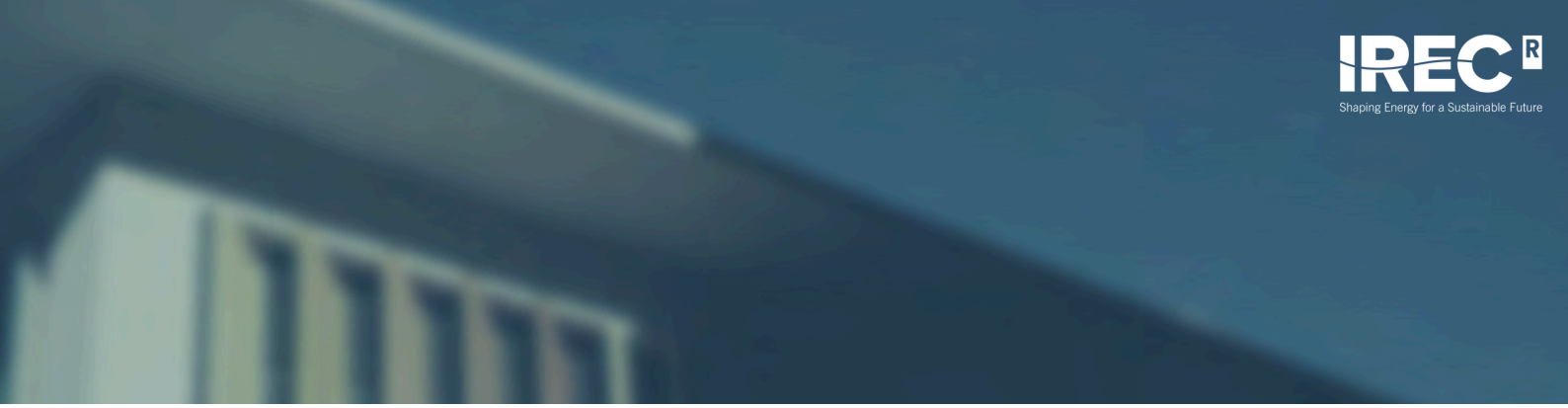
IMPLEMENTATION

The tool is already being used to design components of IFMIF-DONES's High Energy Beam Transport (HEBT) and Beam Dump (BD) line.

EXPECTED BENEFITS

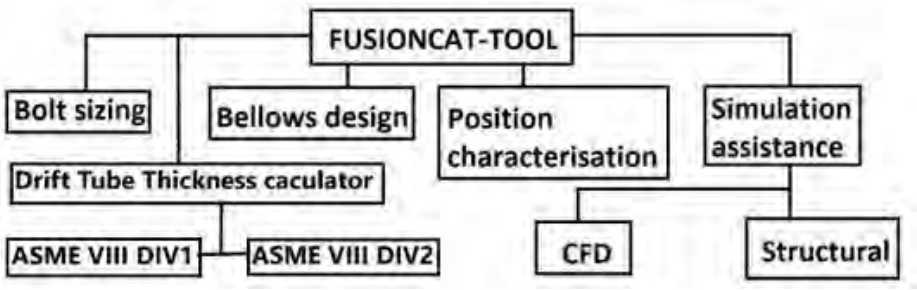
- Validation of designs
- For accelerator fusion components
- Time saving
- Reduces cost

technical details



INNOVATION SOLUTION

The growing need for energy has pushed the necessity of alternate energy sources that can be both sustainable and be enough to cater to the needs of generations to come. Even though fusion has been a fairly old technology, limitations in resources and supporting technologies have resulted in the delay of its adoption. In recent times, significant improvements have been made to cater to these limitations. This tool helps to aid the progress of fusion technologies by developing a platform for designers to be able to perform necessary calculations for designing fusion and accelerator-related components.



TECHNICAL DETAILS

The platform is user friendly. GUI is developed using the open-source programming language PYTHON and its packages, and involves tools for:

- **Bolting Support Design** - validates the design of bolting support as per EN1993 1-8 European standard
- **Expansion Bellows Design** - facilitates designers to as per EJMA standard for various strains (linear, lateral and rotational) related to the expansion bellows
- **Position Characterization** - aids the commissioning activities utilizing linear alignment systems
- **Simulation Assistance** - performs calculations needed by analysis process for both structural and CFD
- **Drift Tube Thickness Calculator** - computes suitable thicknesses for externally pressured vacuum tubes such as accelerator drift tube and others as per ASME BPVC codes

Some icons used in this catalogue are extracted from https://www.flaticon.com/

CONTACT

LOCATION

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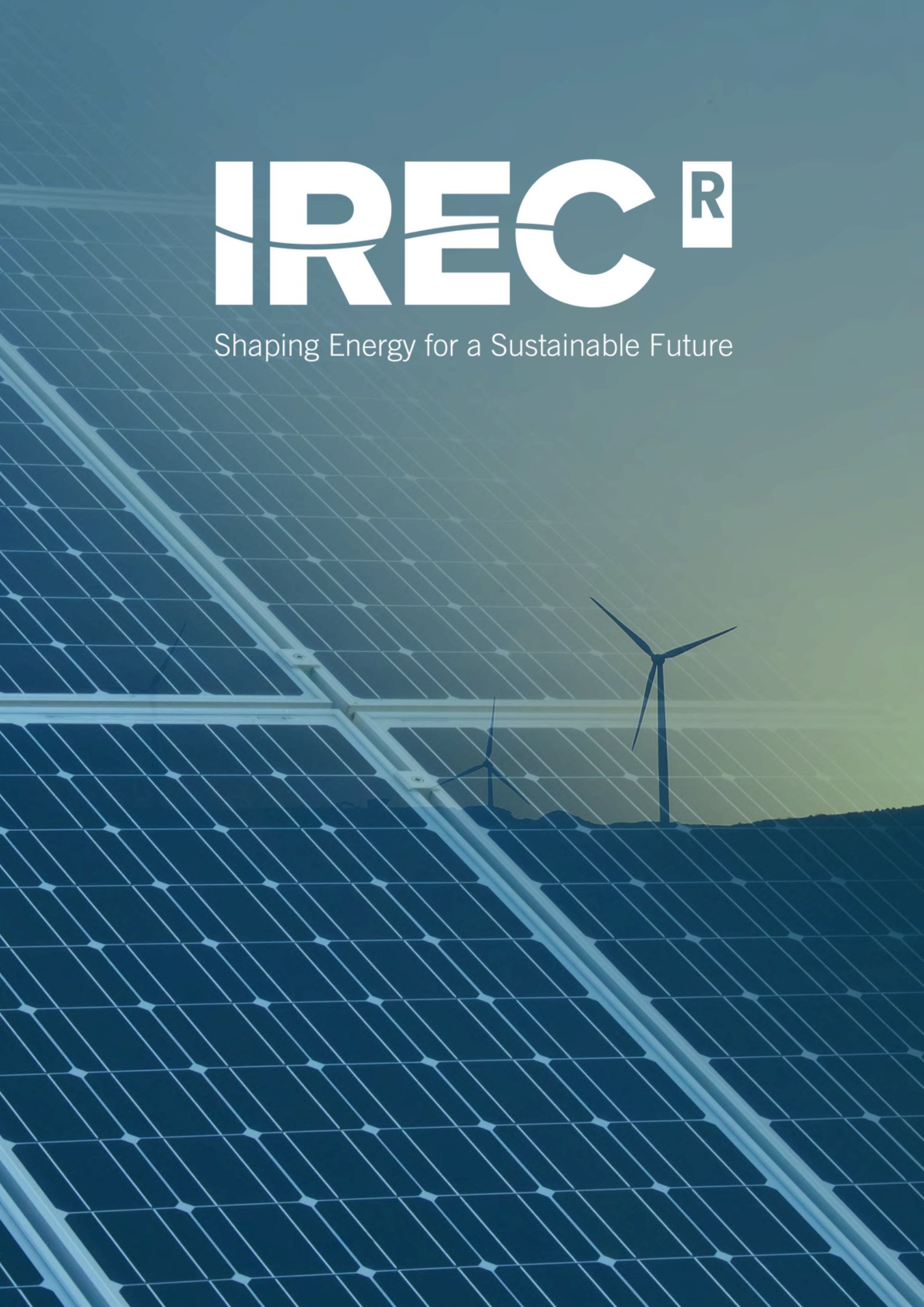
WEBPAGE

Updated information at https://www.irec.cat/ and https://www.irec.cat/tech-transfer/

IREC

Shaping Energy for a Sustainable Future